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INTEGRATED COUPLING UNIT FOR TWO INDEPENDENT
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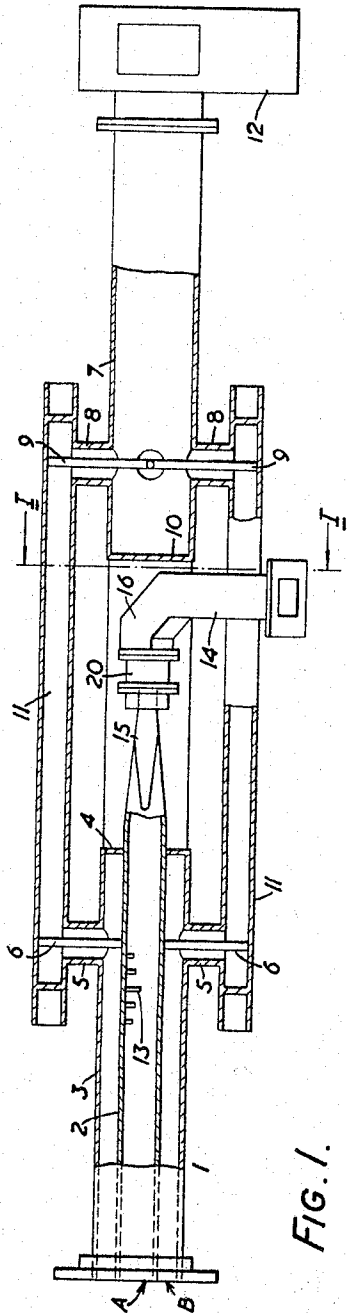


FIG. 1.

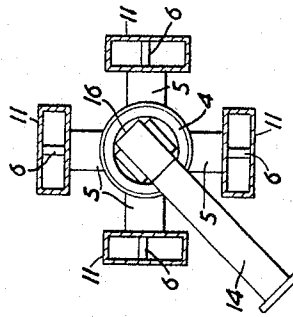


FIG. 2.

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INTEGRATED COUPLING UNIT FOR TWO INDEPENDENT WAVEGUIDE CHANNELS

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This invention relates to waveguide coupling units which may be used to couple two separate microwave circuits to a common microwave aerial.

In this specification "microwave" will be used to mean any electromagnetic wave which is of such a frequency as to be conveniently transmitted by waveguides, and "coupling" will be used to mean electromagnetic coupling.

According to the present invention a waveguide coupling unit includes a coaxial first waveguide section, a circular second waveguide section spaced apart from the first section, a plurality of further waveguides coupling the two waveguide sections, each of the further waveguides being displaced from the axis of each waveguide section, and a feeder waveguide section that passes through the space between adjacent further waveguides and is coupled to the interior of the inner conductor of the coaxial first waveguide section, the arrangement being such that any electromagnetic disturbance present in one of the waveguide sections gives rise to an analogous disturbance in the other waveguide section.

In one embodiment of the invention the coupling unit comprises the coaxial first waveguide section and the second waveguide section, a first set of coupling devices arranged around the periphery of the first waveguide section, a second set of coupling devices arranged around the periphery of the coaxial waveguide section, and a set, preferably four, of further waveguides each linking a coupling device of the first set to a corresponding coupling device of the second set whereby to couple the first and second waveguide sections.

The first and second waveguide sections may be axially aligned, the facing apertures of the two sections each closed by a conducting element and the couplings on each waveguide section arranged at a distance from the short-circuited end of the guide of approximately one quarter of the mean wavelength employed in the guide.

Coupling units constructed in accordance with the invention may be utilised in microwave signalling systems in which it is required to couple two separate microwave circuits to a common microwave aerial. In such signalling systems, the dimensions of the conductors of the first waveguide section advantageously may be so selected that the frequency used for propagation over the circuit defined conjointly by the first and second waveguide sections is too low to be propagated over the circuit defined by the inner conductor of the first waveguide section.

In a particular transmission system embodying a coupling unit as described with reference to the first embodiment above, circular polarisation is employed and the first waveguide section is a circular coaxial section. The second waveguide section and the further waveguides are rectangular, the former being fed with circularly polarised radiation in the TE_{11} mode from a turnstile device. Circularly polarised radiation received by the aerial is fed to the inner conductor of the first waveguide section and converted from a circular polarised TE_{11} mode into plane polarised radiation by a suitable device, e.g. a quarter wavelength phase shifter in that conductor. The plane polarised radiation may be rendered suitable for transmission over a rectangular waveguide by a binomial section or taper section forming part of the feeder waveguide section.

An example of the invention will now be described with reference to the accompanying drawing, in which:

FIG. 1 is a diagrammatic side view, partly in section, of a coupling unit in accordance with the invention, and FIG. 2 is a section taken on the line I—I in FIG. 1.

FIGS. 1 and 2 show one form of waveguide coupling unit embodying the invention and which has a circular coaxial waveguide section 1 and a circular waveguide section 7 displaced from and axially aligned with each other and coupled together by an arrangement including four rectangular waveguides 11. The coupling waveguides 11 extend parallel with and are displaced from the axes of the sections 1 and 7 and bridge the adjacent ends of those sections.

The coaxial waveguide section 1 has inner and outer conductors 2 and 3, at one end the conductor 2 defining a mouth A and at the same end the conductors 2 and 3 together defining an annular mouth B. At the opposite end of the section 1 the outer conductor 3 terminates short of the inner conductor 2 and is connected to it by a short circuiting ring 4. Situated at 90° intervals around the conductor 3 are four radially extending coaxial couplings 5, each having a centre conductor 6 that is connected to the inner conductor 2 at a distance of approximately a quarter wavelength from the ring 4.

The end of the waveguide section 7 that faces the section 1 is closed by a short circuiting plate 10 and four radially extending coaxial couplings 8 are situated around the waveguide 7 at 90° intervals. The coaxial couplings 8 have inner conductors 9 extending within the waveguide 7 and which are connected together at the axis of the waveguide 7 and spaced approximately a quarter wavelength from the plate 10.

Each of the coaxial couplings 5 is connected to a corresponding coupling 8 by one of the rectangular waveguides 11. Correct matching of the two waveguide sections 1 and 7 is ensured by the location of the coaxial stubs 5 and 8 at distances of approximately $\lambda/4$ from the short circuited ends of those sections, as described above, and by suitably dimensioning the transitions between the coaxial stubs and the coupling waveguides 11. The arrangement is such that microwave electromagnetic disturbance present in either the coaxial waveguide section 1 or the waveguide section 7 gives rise to an analogous disturbance in the other one of those sections.

A rectangular feeder waveguide section 14 passing between two of the coupling waveguides 11 is coupled, by an H-plane corner 16, a spacer 20 and a matching section 15, e.g. a binomial or taper section, to the inner conductor 2 of the section 1.

The unit described above provides two discrete microwave signal transmission paths, that defined together by the coaxial section 1, the section 7 and the coupling waveguides 11 and that defined by the hollow inner conductor of the section 1, the corner 16 and the rectangular waveguide outlet.

The coupling unit described above may have the mouths A and B of the section 1 coupled to a microwave aerial via a suitable launching unit to provide a primary feed for the aerial. In a particular embodiment, the transmission path defined together by the sections 1, 7 and coupling waveguides 11 is used to feed energy to the aerial for transmission and the transmission path defined by the conductor 2 is used to feed radiation received by the aerial to receiving apparatus. One such signalling system will be described below.

A microwave generator (not shown) feeds the waveguide section 7 with energy to be transmitted by the aerial at a frequency of about 1700 mc./s. via a turnstile device 12 connected to the aperture of the section 7. The turnstile output is a circularly polarised field in the TE_{11} mode. The resultant electromagnetic disturbance in the

region of the conductors 9 of the coaxial stubs 8 is reproduced, with appropriate phase delay, at the conductors 6 of the stubs 5 and a circularly polarised TE_{11} coaxial mode is transmitted along the coaxial waveguide formed by the conductors 2 and 3 to the mouth B of the section 1.

Circularly polarised radiation at a frequency of 4000 mc./s. received by the aerial is passed down the primary feeder and fed via the mouth A to the inner conductor 2 of the section 1 which acts as a circular waveguide and propagates the received energy in the TE_{11} circular mode. This radiation is converted to plane polarised radiation by a quarter wavelength phase shifter 13 in the conductor 2 and then rendered suitable for transmission in a rectangular waveguide by the binomial section 15 and is deflected through 90° by the H-plane corner 16 into the feeder waveguide 14 which emerges between two of the rectangular waveguides 11 and is then connected to suitable receiving apparatus.

By appropriate dimensioning of the conductors 2 and 3 of the section 1 and use of the frequencies and modes of radiation described, the transmitted radiation cannot be propagated in the receiving channel and hence problems of T-R switching are minimised.

The purpose of the coupling units described above is to provide a coaxial waveguide into or from the inner conductor of which can be injected or extracted, at a point intermediate the ends of the coaxial waveguide, a separate signal from that carried by the coaxial waveguide proper. This is done without interference to the signal carried by the coaxial waveguide proper.

Although in the above description reference has been made to the use of the coupling units each to provide separate transmission and reception channels, it will be appreciated that such a unit could also be used to provide two separate transmission channels or two separate reception channels.

We claim:

1. A waveguide coupling unit comprising a coaxial first waveguide section having circular inner and outer conductors, a circular second waveguide section longitudinally spaced apart from the first waveguide section, a plurality of further waveguides coupling together the first and second waveguide sections so that an electromagnetic disturbance present in either one of the first and second waveguide sections gives rise to an analogous disturbance in the other one of these sections, each of the further waveguides being displaced from the axes of both the first and second waveguide sections, a feeder waveguide section that extends between adjacent of the further waveguides and which is coupled to the interior of the said inner conductor of the first waveguide section, the unit providing thereby two separate microwave transmission paths one defined by the outer conductor of the first waveguide section in combination with the further waveguides and the second waveguide section and the other defined by the inner conductor of the first waveguide section in combination with the said feeder waveguide.

2. A waveguide coupling unit as claimed by claim 1, in which the first and second waveguide sections are axially aligned.

3. A waveguide coupling unit as claimed in claim 1, in which the first and second waveguide sections are axially aligned and in which the end space defined between the inner and outer conductors of the first waveguide section and the facing end of the second waveguide section are closed by respective short circuiting plates, and in which the further waveguides are coupled to the first and second waveguide sections at about a quarter wavelength from the short-circuited ends of those respective sections.

4. A waveguide coupling unit as claimed in claim 3, in which the further waveguides are intercoupled with

the first and second waveguide sections by first and second coupling devices disposed peripherally around the respective first and second waveguide sections, each further waveguide linking a coupling device of the first set with a corresponding coupling device of the second set.

5. A waveguide coupling unit according to claim 1, in which the inner conductor of the first section includes means for converting circularly polarised microwave signals into plane polarised signals.

6. A waveguide coupling unit according to claim 5, in which there is connected to the second waveguide section a device for converting plane polarised microwave signals into circularly polarised signals for transmission in the second waveguide section.

7. A waveguide coupling unit comprising a coaxial first waveguide section having circular inner and outer conductors, a circular second waveguide section axially aligned with and spaced apart from the first waveguide section, a plurality of rectangular further waveguides each bridging the said space between the first and second waveguide sections and spaced apart around the periphery thereof, the said further waveguides intercoupling the outer conductor of the first waveguide section and the second waveguide section whereby the outer conductor of the first section, the said further waveguides and the said second section in combination provide a first microwave transmission path, a feeder waveguide that extends between and transversely adjacent of the further waveguides, and means coupling the feeder waveguide to the interior of the inner conductor of the first waveguide section whereby to define a second microwave transmission path electrically separate from the said first microwave transmission path.

8. A waveguide coupling unit as claimed by claim 7, in which there are four further waveguides equispaced around the peripheries of the first and second sections.

9. A waveguide coupling unit as claimed by claim 8, in which the further waveguides are coupled to each of the first and second waveguide sections by first and second sets of coaxial stubs, the first set of stubs being coupled to the first waveguide section approximately one quarter wavelength from the end thereof facing the second waveguide section, and the second set of stubs being coupled to the second waveguide section at approximately one quarter wavelength from the end thereof facing the first waveguide section, the space between the inner and outer conductors of the first waveguide section being closed by a first short circuit device, and the said facing end of the second waveguide section being closed by a second short circuiting device.

10. A waveguide coupling unit as claimed in claim 7, in which the inner conductor of the first waveguide section includes means for converting circularly polarised microwave signals to plane polarised signals, and there is coupled to the second waveguide section means for converting plane polarised microwave signals into circularly polarised signals for transmission along the second waveguide section.

11. A waveguide coupling unit as claimed by claim 7, in which the feeder waveguide is a rectangular waveguide and a device for coupling a rectangular waveguide to a circular waveguide coupling the said feeder waveguide and the inner conductor of the said first waveguide section.

12. A waveguide coupling unit comprising a coaxial first waveguide section having circular inner and outer conductors, a circular second waveguide section axially aligned with and spaced apart from the first waveguide section, a short circuiting disc closing the end of the second waveguide section facing the first waveguide section, an annular short circuiting disc closing the space between the inner and outer conductors of the first waveguide section at the end thereof facing the second waveguide section, four rectangular further waveguides extending in parallel spaced relation with and bridging the space

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between the first and second waveguide sections, the further waveguides being equispaced about the peripheries of the first and second waveguide sections, first and second sets of coaxial coupling stubs, the stubs of the said first set being coupled to the outer conductor of the first waveguide section approximately a quarter wavelength from the short circuited end thereof and to respective ones of the further waveguides, the stubs of the said second set being coupled to the second waveguide section approximately a quarter wavelength from the short circuited end thereof and to respective ones of the further waveguides, whereby the outer conductor of the first waveguide section in combination with the said further waveguides, the first and second sets of coaxial stubs and the second waveguide section defines a first microwave transmission path of the coupling unit, a feeder waveguide extending between and transversely of two of the further waveguides, and means coupling the feeder waveguide to the inner conductor of the first waveguide section at the short circuited end thereof whereby to define a second microwave

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transmission path of the coupling unit electrically distinct from the first transmission path.

13. A coupling unit according to claim 12, including a turnstile device coupled to the open end of the second waveguide section for converting plane polarised microwave signals into circularly polarised signals in the TE_{11} mode for transmission along the second waveguide section, and in which the inner conductor of the first waveguide section includes means for converting circularly polarised microwave signals in the TE_{11} mode into plane polarised microwave signals.

References Cited by the Examiner

15 Southworth: "Principles and Applications of Waveguide Transmission," Van Nostrand, New Jersey, September 1961, QC661, S8, Figure 9.6-3(b), page 355.

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