June 30, 1970 M. HOFFMAN 3,518,579

MICROSTRIP WAVEGUIDE TRANSDUCER

Filed May 29, 1968

Fig. 1

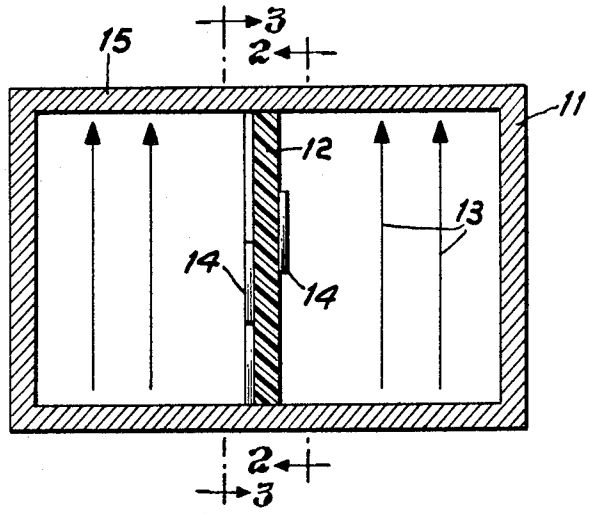


Fig. 2

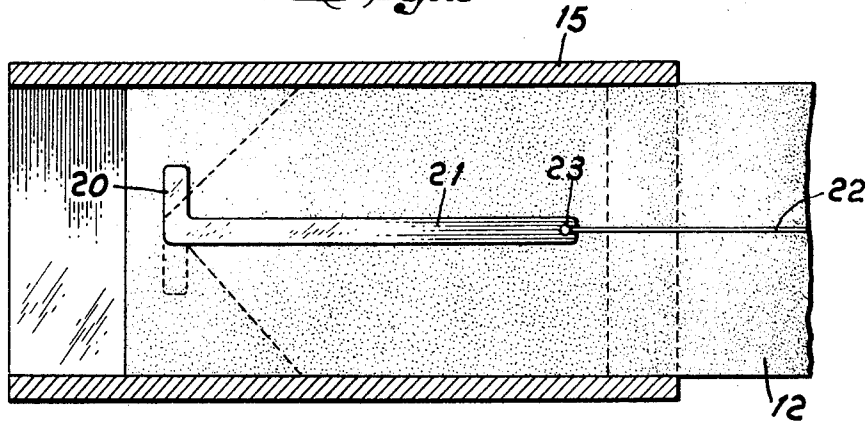
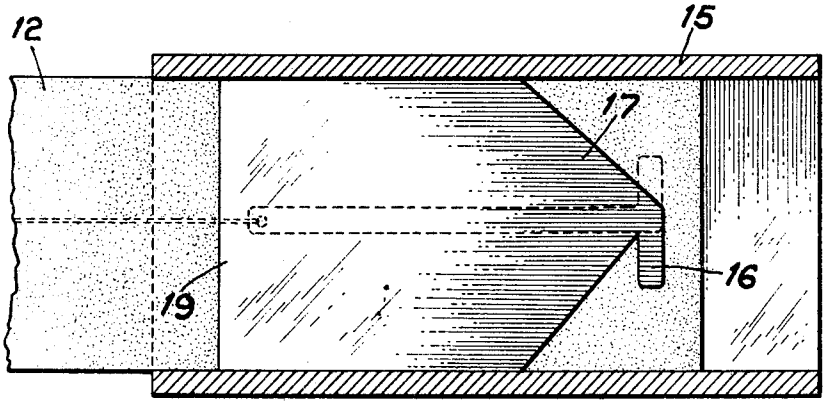


Fig. 3



INVENTOR
MURRAY HOFFMAN
BY Marietta J. Lombardi
ATTORNEY

United States Patent Office 3,518,579
Patented June 30, 1970

3,518,579

MICROSTRIP WAVEGUIDE TRANSDUCER

Murray Hoffman, Livingston, N.J., assignor to International Telephone and Telegraph Corporation, Nutley, N.J., a corporation of Delaware

Filed May 29, 1968, Ser. No. 732,943
Int. Cl. H01p 1/16, 3/00, 1/00
U.S. Cl. 333—21 8 Claims

ABSTRACT OF THE DISCLOSURE

A waveguide transducer is provided in which a microstrip printed circuit board is located in the central plane of the waveguide in parallel to the electric field of a wave introduced therein. A broadband dipole is located on said microstrip to transduce the power of the wave into the microstrip.

BACKGROUND OF THE INVENTION

In general this invention relates to microwave devices, and more particularly to a microstrip waveguide transducer in which the electric field of a wave is transduced into the microstrip.

In one arrangement according to the prior art, a transducing fin is placed perpendicularly to the electric field lines in a rectangular waveguide so as to transduce into a round waveguide having a ferrite rod coaxial with it to produce Faraday rotation. In another arrangement according to the prior art, a tapered transition, at least two wavelengths long, is shaped like a horn with a ridged waveguide fin in its middle to transduce from the strip line to the waveguide. In this arrangement the ground plane is parallel to the broad wall of the waveguide.

In yet another arrangement, the transducing is into a coaxial line by means of a tapered ridge. A further arrangement does not transduce from waveguide to microstrip, but utilizes directional coupling in the microstrip or strip line. And still a further arrangement according to the prior art couples two double shielded strip transmission lines by means of slots cut into a narrow wall of a waveguide, these are common to one of the ground planes of the strip transmission line. The differences between the coupling and transducing methods according to the prior art and the arrangement according to the invention which become more evident by the following description.

SUMMARY OF THE INVENTION

It is an object of this invention to place an antenna parallel to the electric field within a waveguide to transduce the power into a microstrip.

Another object of this invention is to provide a microstrip ground plane which perpendicular to the waveguide broad wall, and to use the antenna to transduce the power into the microstrip.

According to the broader aspects of this invention there is provided a waveguide transducer for a waveguide having a wave introduced therein, the transducer including a microstrip printed circuit board located in the central plane of said waveguide and in parallel to the electric field of the wave, and antenna means on said board to transduce the power of said wave into said microstrip.

A feature of this invention is that the microstrip waveguide transducer includes a dipole antenna, the wings of the dipole antenna being located on opposite sides of the circuit board, one side of which is utilized as a ground plane.

Another feature of this invention is that the dipole within the waveguide is parallel to the E field and the one side broadens into the ground plane to short the top and bottom walls of the guide and cut off the signal. This side becomes the ground plane for the entire microstrip. The other dipole wire carries the signal and becomes a narrow conductor of the microstrip, so that the signal may be operated on if desired, or transduced in the same manner back into the waveguide. Therefore, everything may be done within the waveguide itself.

BRIEF DESCRIPTION OF THE DRAWING

The novel features of this invention will be more clearly understood when considered in light of the following description taken together with the accompanying drawings in which:

FIG. 1 is a cross-section of a waveguide having a microstrip transducer placed therein;

FIG. 2 is a cross-section showing one side of the microstrip taken along the lines 2—2 of FIG. 1; and

FIG. 3 shows the opposite side of the microstrip and is taken along lines 3—3 of FIG. 1, showing the grounded plane side of the microstrip.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a waveguide **11** and a microstrip printed circuit board **12** which is mounted parallel to a wave electric field indicated by arrows **13**. A thick broadband dipole **14** is located on the board **12** in the central plane of the waveguide **11** and in a plane perpendicular to the waveguide broad wall **15**. The wave introduced within waveguide **11** is transduced into the microstrip by this antenna which is a short dipole whose wings are attached to a very short length of wire lines.

Referring to the additional drawings, we see that one of the wings **16** in FIG. 3 broadens out by a taper **17** or a series of transformer steps into a ground plane across the full width of the guide **15** to short out the top and bottom walls by its continuity, and thereby, driving the guide to cut-off at all its normal transmission frequencies. Therefore, side **19** of the microstrip **12** becomes the ground plane for the entire microstrip circuit which now becomes the only transmission path possible on which all the microwave energy can flow in the shielded cutoff region in the waveguide.

The other wing **20** of the dipole as shown in FIG. 2, is transformed into the narrow upper conductor **21** of the microstrip circuit. Conductor **21** is adapted to connect to a wire or line **22** so that the energy may be coupled and acted upon by passive or active elements in the microstrip network (not shown), for example, filters, couplers, ferrite devices, or semiconductors. The narrow waveguide wall adjacent point **23** may be drilled or cut away to provide access for a control or signal lead to the microstrip network. The processed signal may be taken out on a coax or two wire line or as is obvious transduced back into the waveguide by means of the connection to point **23**.

A waveguide with an integral microstrip network could easily serve as a low noise amplifier in a feedhorn illuminating an aperture, or it could be used as an integral element and phase shifter in a phased array. It could also be used with an antenna directly as in an antennafier or antenna verter.

This arrangement places a dipole antenna parallel to the electric field to transduce its power into the microstrip. The microstrip ground plane as represented by side **19** which is perpendicular to the waveguide broad wall **15** to cutoff all normal frequencies of the waveguide. No taper of the waveguide walls are necessary since the microstrip can be enclosed within the waveguide. All of the wavepower within the waveguide is transferred and all the processing on the signal may be incorporated on

the printed circuit board within the waveguide itself. An alternate means of processing the signal is to couple from the narrow upper conductor through the narrow wall in the waveguide to the processing devices by means of a coaxial or two-wire line. Due to the flexibility of this system, the wave may be directly introduced into the waveguide from a processing network by utilizing this method in the reverse.

This arrangement eliminates the need for intermediate couplings between waveguide and microstrip. This arrangement is useful for lens type phase arrays and for integrating low noise front ends with large aperture dishes and for R.F. switching systems. Tests have shown that waveguide mode leakage past the microstrip printed circuit board is down more than 25 db.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this is made only by way of description and not as a limitation to the scope of my invention as set forth in the accompanying claims.

I claim:

1. A waveguide transducer comprising:
a waveguide adapted for having a wave introduced therein;
a microstrip printed circuit board located in the central plane of said waveguide and in parallel to the electric field of said wave; and
antenna means on said board to transduce the power of said wave into said microstrip, said antenna means is a dipole antenna, the wings of which are located on opposite sides of said board.

2. A transducer according to claim 1, in which one of said wings of the short dipole is coupled into a ground plane which extends the full height of the guide.

3. A transducer according to claim 2 wherein said ground plane is perpendicular to the waveguide broad wall.

4. A transducer according to claim 3 in which the other one of said wings of the dipole is coupled to a narrow conductor which is adapted to couple the wave for processing.

5. A microstrip waveguide transducer comprising:
a rectangular waveguide having a wave introduced therein;
a microstrip printed circuit board positioned in the central plane of said waveguide and in parallel to the electric field of said wave; and
a dipole antenna on said board to transduce all the power of said wave into said microstrip, and each wing of said dipole is located on an opposite side of said board.

6. A transducer according to claim 5 in which one of said wings of the short dipole broadens into a ground plane which extends the full height of short wall of the guide.

7. A transducer according to claim 6 wherein said ground plane is perpendicular to the waveguide broad wall to drive the guide to cutoff at all its normal transmission frequencies.

8. A transducer according to claim 7 in which the other one of said wings of the dipole is coupled to a conductor which is adapted to connect the transduced wave to processing elements.

References Cited

UNITED STATES PATENTS

2,530,818	11/1950	Fox	333—31
3,114,888	12/1963	Wilson	333—21 X
3,375,474	3/1968	Thompson et al.	333—21

HERMAN KARL SAALBACH, Primary Examiner
M. NUSSBAUM, Assistant Examiner

U.S. Cl. X.R.

333—84, 98