

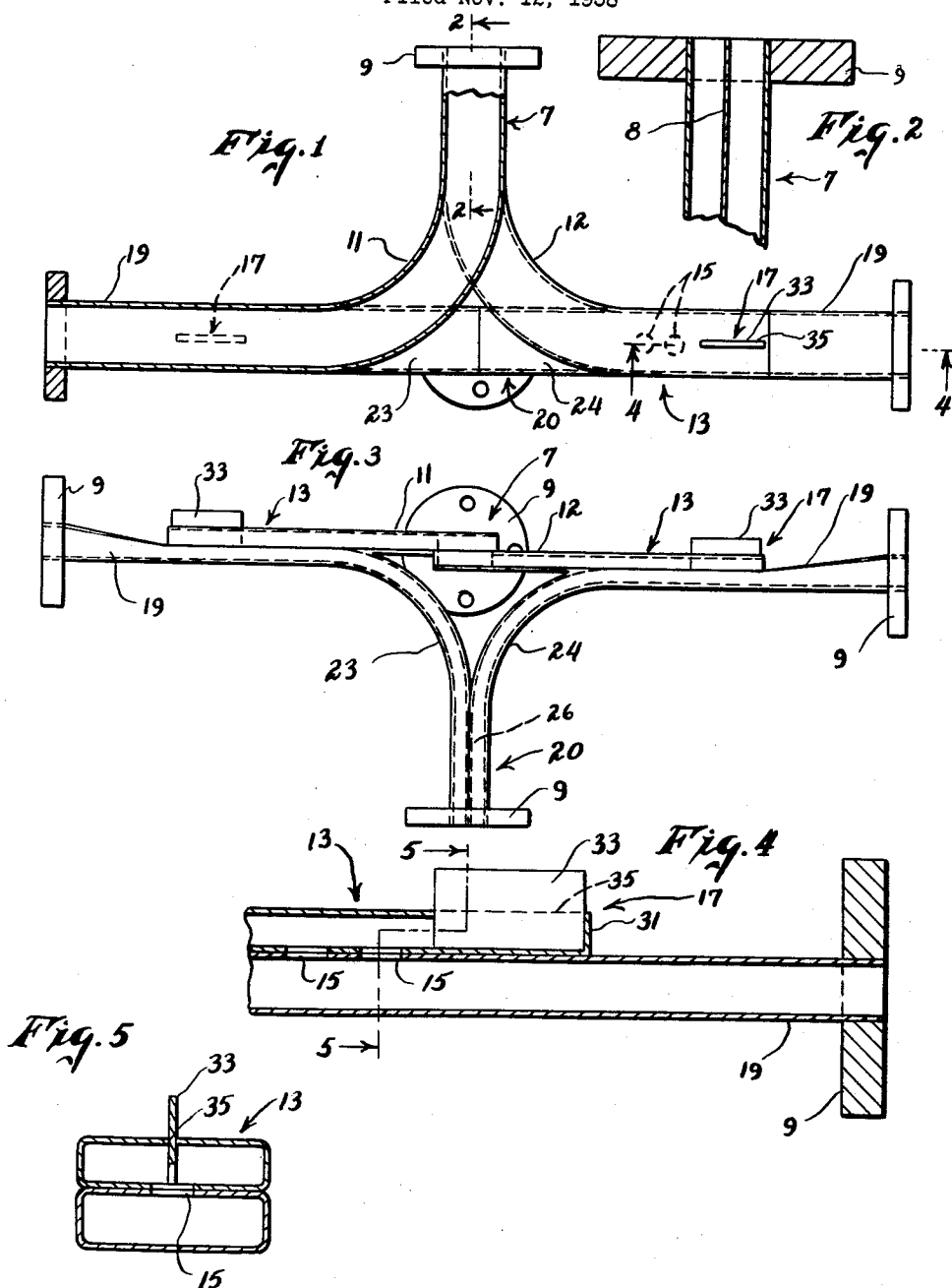
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MATCHED MAGIC TEE

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MATCHED MAGIC TEE

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9 Claims. (Cl. 333—11)

This invention relates to matched magic tee's for magnetic wave guides, and has for its principal object, the attainment of superior balancing and matching characteristics over a very wide frequency region, this frequency region being equivalent to the coverage of the wave guide itself.

A further object is the attainment of a theoretically perfect isolation between the in-put wave guide and out-put wave guide at a balanced condition, a characteristic which was unobtainable in the old magic tee.

As a further object, the attainment of a perfect isolation between the in-put wave guide and out-put wave guide as hereinabove stated, gives rise to and allows for a super-sensitive magic tee impedance bridge.

A further object of the matched magic tee is an improved functioning of the invention with each arm capable of easy adjustment separately.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

Figure 1 is a top view, partly in section, of a magic tee made in accordance with this invention;

Figure 2 is an enlarged sectional view taken on the line 2—2 of Figure 1;

Figure 3 is a front elevation of the magic tee shown in Figure 1;

Figure 4 is an enlarged sectional view taken on the line 4—4 of Figure 1; and

Figure 5 is a sectional view taken on the line 5—5 of Figure 4.

The matched magic tee of this invention can be constructed of different kinds of metal provided that the microwave loss is small enough to permit use of the tee at microwave frequency. Some suitable metals are brass, copper, silver, coin silver and stainless steel, but the invention is not limited to these metals. The matched magic tee of this invention can be operated at any frequency region.

The structure shown in the drawing includes a first wave guide assembly 7 having a septum 8 (Figure 2), and a flange 9 at the entrance end of the wave guide assembly. The wave guide assembly has two H-bend wave guides 11 and 12; and it has two directional couplers 13, each of which is made up with coupling holes 15 and no-reflection ends 17. The directional couplers 13 lead the input power to the load impedance through load arms 19. These load arms 19 form part of a second wave guide assembly 20 having E-bends 23 and 24 which bring the load arms together at the outlet end of the magic tee. There is a septum 26 separating the opposite sides of the wave guide assembly where the E-bends 23 and 24 come together, this septum 26 preferably extending to the discharge end of the magic tee.

There are flanges 9 on both of the load arms 19 and also at the discharge end of the wave guide assembly 20.

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The input power supplied to the wave guide assembly 7 is equally divided between both sides of the wave guide assembly by the septum 8, composed of a thin strip of metal, preferably copper, brass or silver. This septum 5 may be a separate strip of metal or it can be of one-piece construction with the H-bends 11 and 12. The septum 26 at the outlet end of the magic tee can be of similar construction.

The magic tee is connected with the input power supply, the output, and the load wave guides by means of the flanges 9 and in accordance with conventional practice well understood in the art.

Each of the no-reflection ends 17 includes an end wall 31 at the ends of the wave guides which include the 15 E-bends; and includes also a plate 33 inserted into the wave guide through a slot 35 in the top wall of the wave guide. The plate 33 has at least its surface made of resistive material, such as spattered metal or carbon applied to an insulating plate, such as glass, plastics and Bakelite.

One half of the power supplied to the input end of the magic tee travels through each of the E-bends 11 and 12 and then through the holes 15 of the directional couplers 13. Any power which does not pass through 25 the holes 15 travels on to the no-reflection end 17 and is completely absorbed.

If there is an un-matched load at one load arm, power is reflected back from the un-matched load, and this power flows around the E-bend from the load arm having the un-matched load. When this power with the un- 30 matched load meets the power from the E-bend on the other side of the magic tee, there will be unbalanced power on opposite sides of the septum 26.

If the load arms have equal loads, then the power coming to the output of the tee through the H-bends 23 and 24 is equal and the output power at the end of the wave guide assembly 20 is zero because the reflected waves are equal and of opposite phase at the outlet end of the magic tee. The construction provides an infinite isolation between the input and the output of the magic 40 tee at all frequencies.

Either the E-bend or the H-bend can be at the input or output end of the assembly, but the directional couplers and the load arms must be in the illustrated relation to the input and output wave guides.

Because of the fact that this magic tee obtains a zero output when the load arms are in balance, it will be apparent that a very small change of impedance in either load arm induces a large change at the output end of the magic tee and there is no limit to the sensitivity of the bridge used with the tee of this invention.

The most significant characteristic of the magic tee of this invention, which makes it superior to those of the prior art, is that the balancing can be maintained perfectly at any frequency. This was impossible with magic 55 tee's of the prior art.

The path lengths for the microwaves from the input to the output of the magic tee by way of the different load arms are exactly equal. Thus, the microwave 60 fields which meet together at the output end of the tee are of the same amplitude and they offset each other because of their opposite phase. The magic tee of this invention can be constructed by any of the known methods for constructing and joining materials which will transmit microwaves, for example, by soft soldering. The size of the magic tee depends upon the frequency, it being made smaller for high frequency and larger for low frequency, in accordance with well-known practice.

The preferred construction of the invention has been 70 illustrated and described, but changes and modifications can be made and some features can be used in different

combinations without departing from the invention as defined in the claims.

What is claimed is:

1. A matched magic tee comprising a first wave guide assembly having an energy input opening at one end and having two wave guides that diverge from one another, a second wave guide assembly having two wave guides, directional couplers connecting different diverged ends of the first wave guide assembly with different wave guides of the second wave guide assembly, the second wave guide assembly having an outlet and at which both arms of the second wave guide come together, the directional couplers for the different wave guides being located in positions to produce waves of opposite phase in the different wave guides of the second assembly at their outlet ends.

2. The matched magic tee described in claim 1 and in which both the first and second wave guide assemblies have their wave guides extend for a substantial distance from one end side by side and then diverge from one another, and in which the total lengths of the diverging portions of each wave guide assembly are the same in length.

3. The matched magic tee described in claim 2 and in which there is a septum separating the wave guides in each of the wave guide assemblies extending for at least a part of the length of the wave guide assembly ahead of the location where the wave guides begin to diverge.

4. The matched magic tee described in claim 3 and in which the septum of each wave guide assembly extends along the full distance from one end of the wave guide assembly to the location where said wave guides diverge and separate from one another.

5. The matched magic tee described in claim 1 and in which each of the E-bends of one wave guide assembly is connected with the corresponding H-bend of the other wave guide assembly by a directional coupler.

6. The matched magic tee described in claim 5 and in which the directional couplers are located some distance back from corresponding ends of the wave guide as-

semblies, and there is an element of resistive material in the wave guides beyond the directional couplers for absorbing energy that passes beyond the directional couplers and thereby preventing reflection of energy back against the intended direction of movement of the waves along the guides.

7. The matched magic tee described in claim 1 and in which a run of each of the H-bends of the first wave guide assembly extends immediately adjacent to a corresponding end of one of the E-bends of the second wave guide assembly, and there are openings through the separating walls of the wave guide assemblies forming directional couplers through which waves from one wave guide enter the other, and there are elements beyond the couplers for preventing reflection of waves that pass the couplers.

8. The matched magic tee described in claim 1 and in which each of the E-bends of one wave guide assembly is connected with the corresponding H-bend of the other wave guide assembly by a directional coupler, and the diverged ends of the first wave guide assembly are closed beyond the coupler and the corresponding ends of the second wave guide assembly have end fittings adapted to be connected to loads.

9. The matched magic tee described in claim 1 and in which each of the E-bends of one wave guide assembly is connected with the corresponding H-bend of the other wave guide assembly by a directional coupler, and the diverged ends of the first wave guide assembly are closed beyond the coupler and there are longitudinally extending slots in the first wave guide assembly beyond each of the couplers and there are plates fitting through said slots extending to a wall of the wave guide opposite the slot, said plates being made with resistive material for absorbing energy that leaks past the coupler.

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