

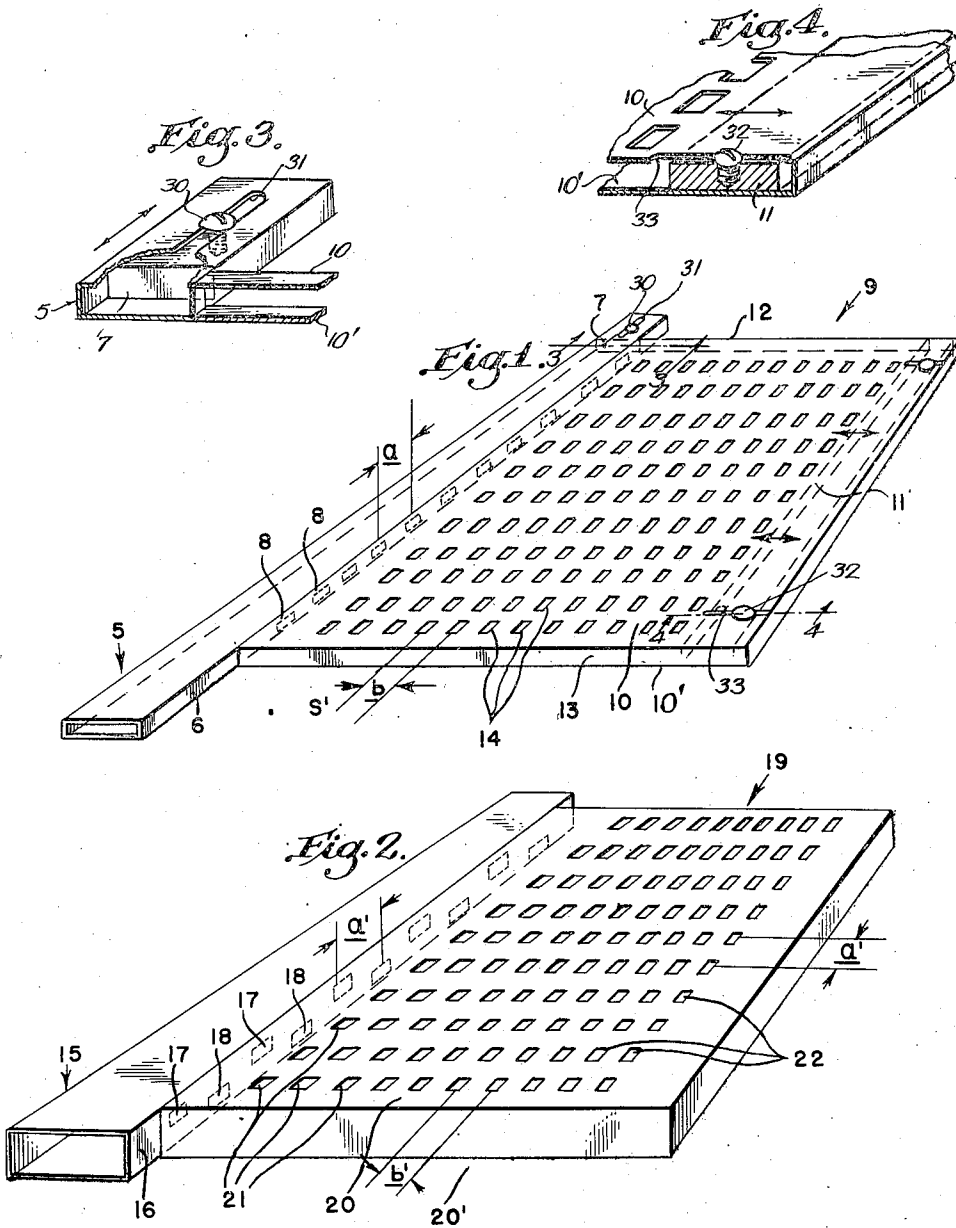
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This invention relates to antenna and more particularly to antenna adapted for use with high frequency communication systems.

One object of this invention is to produce a highly directive beam of radiation. Further objects, novel features, and advantages of the invention will be apparent from the description contained herein.

Fig. 1 illustrates one embodiment of the invention; and

Fig. 2 illustrates a preferred embodiment of the invention.

Fig. 3 illustrates a sectional view taken along line 3—3 of Fig. 1; and

Fig. 4 illustrates a sectional view taken along line 4—4 of Fig. 1.

Rectangular wave guide 5 has a plurality of apertures 8 preferably in one narrow wall 6 thereof, these apertures being spaced apart a distance a which is substantially equal to a wavelength in the guide, and is terminated by an adjustable plunger 7. Parallel plate waveguide 9 comprising two conductive parallel plane plates 10 and 10', extends generally normal to the wall 6 of wave guide 5 in which the apertures 8 are provided.

Wave guide 9 restricts the radiation from apertures 8 to the space between its plates 10 and 10', that is, generally speaking, to a plane normal to wall 6 and parallel to the axis of wave guide 5. Wave guide 9 is terminated by a movable plunger 11 along the side opposed to apertures 8. As will be apparent from the explanation to follow, the other two sides 12 and 13 of wave guide 9 may be closed or not, as desired.

One plate 10 of wave guide 9 has a plurality of apertures 14 therein spaced apart a distance b corresponding to the wavelength in wave guide 9, which may be the same as the free space wavelength at the frequency contemplated.

If energy is directed into wave guide 5 in the direction of plunger 7, part of the energy will leak or escape through apertures 8. Plunger 7 may be faced with energy-absorbent material, or have a reflecting surface, and is adjusted to reduce the standing wave ratio to a minimum in wave guide 5. As shown in Fig. 3, plunger 7 moves within wave guide 5 in the direction of the arrow. To make a desired adjustment, set screw 30 is moved, in the direction of the arrow, within slotted portion 31 of wave guide 5. It is preferred that distance a approach the free space wave length, and in any event since energy escaping from apertures 8 is in phase, the major portion of the energy will be directed normally to the wall 6 contain-

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ing apertures 8. Thus, it will be seen that it is not necessary to have side walls 12 and 13 to wave guide 9 although these may be included to minimize the escape of energy contained in side lobes of radiation from aperture 8, and may be of energy absorptive material. Apertures 14 are in alignment with apertures 8 and are spaced apart a distance b of substantially one wavelength. Plunger 11 is adjusted to reduce the standing wave ratio in wave guide 9. As shown in Fig. 4, plunger 11 moves between parallel plates 10, 10' in the direction of the arrow. To make a desired adjustment, set screw 32 is moved, in the direction of the arrow, within slotted portion 33 of plate 10. Energy escaping from apertures 14 is in phase in all directions parallel to plate 10 containing apertures 14, and thus a narrow, directed pencil beam will extend normally to plate 10.

It will be observed that if the distance a could be made less than a free space wavelength, side lobes could be reduced. This may be accomplished in the manner illustrated in Fig. 2. Wave guide 15 is a rectangular wave guide having broad side wall 16 in which are a plurality of apertures 17 and 18. If energy is propagated through wave guide 15 in the TE₀₁ mode with electric vectors normal to side 16, then the currents along broad wall 16 at any cross section transverse to the longitudinal axis of wave guide 15 will be in phase opposition on opposite sides of a longitudinal central line along broad wall 16. Therefore, apertures 17 may be spaced from apertures 18 by a distance a' substantially a half wave length in the wave guide 15 at the frequency involved, and by staggering apertures 17 and 18 on opposite sides of the longitudinal median line of broad wall 16, radiation from all the apertures will be in phase. A parallel plate wave guide 19 having plates 20 and 20' may be extended generally normal to broad wall 16 in a manner similar to that in which parallel plate wave guide 9 extends normally to narrow wall 6 of wave guide 5 in Fig. 1. In one plate 20 of wave guide 19 of Fig. 2 are an array of apertures 21 and 22 aligned with apertures 17 and 18 respectively, and also spaced apart a distance a' in the direction parallel to broad wall 16. In the direction normal to broad wall 16 they may be spaced apart a distance b' substantially equal to one wave length in free space. Thus a narrow directed pencil beam will extend normally to plate 20 containing apertures 21 and 22.

A further improvement may be obtained by reducing the distance b' (or b) to a value less than the free space wavelength, even though

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slightly less, which will result in materially reducing side lobes. The radiation then will not be normal to plate 20, but will still be a pencil, or directed beam, with side lobes reduced. Although not shown in Fig. 2, adjustable plungers may be used in a manner similar to that in which they are employed in the device shown in Fig. 1 in order to reduce standing waves within wave guides 15 and 19.

As is well known in the art, antennas having directive effects in radiation conversely have like directive effects in reception and similar structures may be used for radiation or reception of electromagnetic energy.

Many variations will be apparent to those skilled in the art, and therefore it is not desired to restrict the scope of the invention to the precise embodiment herein disclosed.

What is claimed is:

1. In combination, a rectangular wave guide having apertures along one wall thereof spaced at equal intervals of substantially one wavelength in the guide at the operating frequency, and a parallel plate wave guide whose plates extend substantially normal from said one wall, one of said plates having openings therein in alignment in a direction normal to said one wall with the apertures in said one wall and spaced apart substantially one free-space wavelength at the operating frequency in the direction normal to said one wall, whereby a pencil beam of electromagnetic energy may be radiated into space from said parallel plate wave guide in a direction normal to the said one plate.

2. The combination of claim 1, including an adjustable plunger termination in said rectangular wave guide and an adjustable plunger termination in said parallel plate wave guide.

3. In combination a rectangular wave guide having apertures equally spaced along one wall thereof, and a parallel plate wave guide having plates which extend substantially normal from said one wall, one of said plates having openings in alignment in a direction normal to said wall with said apertures, said openings being also aligned in a direction parallel to said wall, and spaced apart equally in a direction normal to said wall, whereby a pencil beam of electromagnetic energy may be radiated into space from said openings.

4. The combination of claim 3 including an

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adjustable plunger termination in said rectangular wave guide and an adjustable plunger termination in said parallel plate wave guide.

5. A directive antenna comprising a first rectangular wave guide having apertures along one wall thereof spaced at equal intervals of substantially one half wave length in the guide at the operating frequency, said apertures being staggered on opposite sides of the longitudinal median line of said wall, and a parallel plate wave guide whose plates extend substantially normal from said one wall, one of said plates having openings therein in alignment in a direction normal to said one wall with the apertures in said one wall and spaced apart in the direction parallel to said one wall at intervals equal to those of the apertures in said one wall, said plate openings being spaced apart in the direction normal to said one wall at equal intervals of substantially one wave length in free space at the operating frequency.

6: A directive antenna comprising a first rectangular wave guide, one of the walls thereof having a plurality of equally spaced apertures formed therein, said apertures being staggered on opposite sides of the longitudinal median line of said wall, and a second wave guide including two parallel plates normal to said apertured wall and enclosing said apertures, one of said enclosing plates having apertures therein in alignment in a direction normal to said one wall with the apertures in said one wall and spaced apart in the direction parallel to said one wall at intervals equal to those of the apertures in said one wall, said plate apertures being spaced apart at predetermined intervals in the direction normal to said one wall.

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