

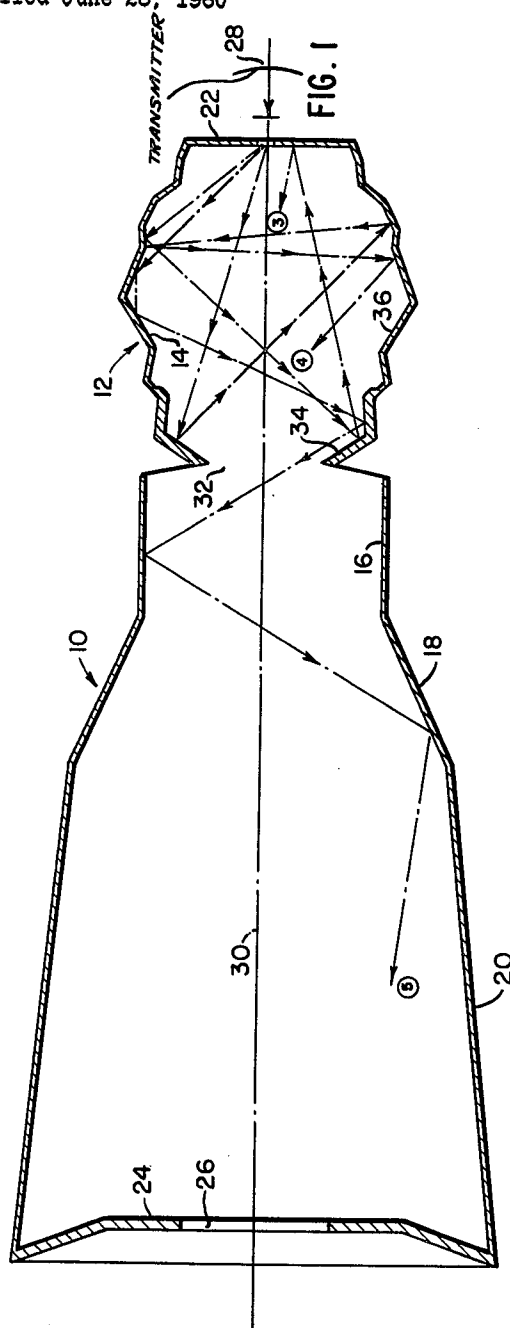
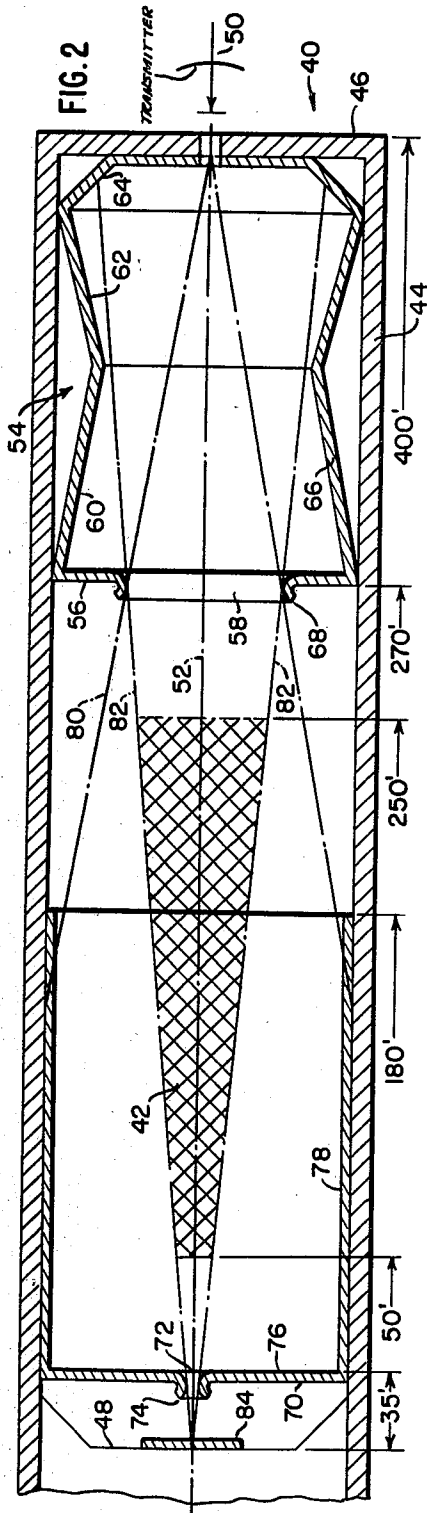
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MICROWAVE ANECHOIC CHAMBER

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MICROWAVE ANECHOIC CHAMBER

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This invention relates in general to microwave anechoic chambers, and more particularly to a new and improved microwave anechoic chamber having a tubular housing with an apertured wall or baffle mounted transversely within the housing, effective to limit the amount of reflected energy reaching a free zone located within the chamber.

Many microwave anechoic chambers have been constructed as simple rectangular boxes lined with absorbing materials of various types which reduce reflectivity of electromagnetic energy from walls, ceilings and floors within the functional frequency range of the particular absorber used. Absorbing materials are presently available which reflect less than one percent of the electromagnetic energy within the frequency range of 50 mc. to 50 K mc. These one percent materials are normally referred to as the 20 decibel or 20 db absorbers. A few materials are available which exhibit power reflectivity of 30 db (0.1%) or even 40 db (0.01%) over limited portions of the frequency range. As may be expected, the cost of these absorbing materials increase in proportion to their decibel ratings.

Obviously then, the decibel performance of a test chamber may be controlled to some extent by selecting an absorbing material having a decibel rating comparable to the performance desired. While this may be an effective solution for small size test chambers intended to function in the 20-20 db range, the cost involved in lining even a conventional sized chamber with absorbing material in the 30 to 40 db range is prohibitive. Similarly, large chambers fully lined with 20 db absorbing material would be extremely expensive.

In some installations, a series of absorber covered baffles project into the room with their edges disposed transversely to the line of sight between the transmitter and the target. When a standard 20 db absorber is used in the room and on the baffle, the baffle edges inevitably set up diffraction fields which, even in a large room, may limit the reflected energy level to little more than 30 db down with respect to direct ray level at certain points in the room and at certain frequencies. Furthermore, toward the low frequency limit of the absorbing material, the details of the physical edges of the baffles, the sharpness of the edges for example, are of secondary importance. Even the quality of the absorbing material covering the baffle edges is secondary in importance to the fact that the edges exist. For the angles of edge illumination and reflection which are encountered in the conventionally baffled darkroom, the very existence of baffle edges sets the limitation on the decibel performance of the chamber.

It is an object of the present invention to provide a microwave anechoic chamber wherein there is a quiet volume in which the decibel performance is significantly greater than the decibel reflectivity of the absorbing material used to cover the major portion of the surrounding walls, ceilings and floors.

Another object of this invention is to improve substantially the decibel performance of anechoic chambers without resorting to expensive, highly absorptive material.

Yet another object of this invention is to provide an anechoic chamber in which potentially troublesome microwaves are trapped at the transmitting end of a

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chamber so that the target at the receiving end of the chamber will be illuminated only by microwave energy propagated directly from the transmitting antenna.

Still another object of this invention is to provide a microwave anechoic chamber only partially lined with absorber material yet having a room performance somewhat higher than the decibel rating of that absorbing material.

More particularly, this invention features a microwave anechoic chamber in which the transmitting and receiving portions are separated by a single transverse wall or baffle having an aperture formed therein. The aperture is located on the axis of propagation of a microwave transmitter mounted in the transmitting end of the chamber and, along with the baffling, effectively traps substantially all extraneous microwaves so that only the direct and desired amount of energy will pass into the receiving portion of the chamber to illuminate the target. According to this invention, the edge of the aperture itself is the only diffracting edge visible simultaneously from both transmitting and receiving points. This feature makes possible the significant improvement in room performance over the obtainable with a conventional transversely baffled chamber.

These and other novel features of the invention together with further objects and advantages thereof will become apparent from the following detailed specification with reference being made to the accompanying drawings in which:

FIG. 1 is a top-plan view of a microwave anechoic chamber made according to this invention, and

FIG. 2 is a top-plan view showing a modification of the invention.

Referring now to FIG. 1, there is illustrated an anechoic chamber 10 designed to meet particularly critical reflectivity requirements. The chamber has an operational performance in the 40 to 50 db range and is particularly adapted for use as a boresighting range for transmitter and receiver antennas.

The test chamber illustrated in FIG. 1 is a generally funnel-shaped affair of approximately 100 feet in over-all length, including an outwardly flared, bell-like housing 10 adjoining and in communication with a transmitting cell 12 characterized by some rather complicated transverse baffles 14.

In cross section, both the housing and the cell are rectangular and of varying dimensions according to the point of cross section. Other cross-sectional configurations may be used in place of the rectangular shape described. For instance, either or both the housing and the cell may be annular in cross section, as desired.

The bell shaped housing 10 comprises a rather narrow waist portion having parallel side walls 16 merging into sharply diverging wall portions 18 which in turn joins with more moderately diverging portions 20. Oppositely facing end walls 22 and 24 complete the general structure of the chamber. The end wall 24 is covered with absorbing material formed as a shallow truncated pyramid with a central aperture 26 in the shape of a diamond. The aperture 26 defines and surrounds a receiving or quiet area approximately 14 feet by 8 feet, producing a decibel performance in the 40 to 50 db range when a transmitter 28 is located in the center of the end wall 22.

During boresighting operations, one or several antennas are mounted on a reference plate at the transmitting end of the chamber. The reference plate should be attached to a transmitter stand in such a way that the center of each parabolic reflector is not more than about 20 inches from the longitudinal axis 30 of the room. Only one antenna at a time should be energized during the boresighting procedure, and the function of the operation is

to determine the direction in which the main beam of the antenna is pointing with respect to the reference plate. The direction of the beam may be determined by means of an interferometric antenna array which should be mounted in the quiet volume located within the aperture 26.

It will be noted that the cell 12 is constructed in such a manner that the baffling 14 defines a restricted aperture 32 of rectangular outline. Other shapes such as a polygon, circle or ellipse may be desirable under some circumstances. Since the aperture edge itself is the only diffracting edge visible simultaneously from both transmitting and receiving points, significant improvement in performance is accomplished over that obtainable with a conventional transversely baffled chamber of similar overall dimensions. Furthermore, since the aperture 32 precludes direct illumination by the transmitter of the side walls, ceiling and floor of the chamber between the aperture and the quiet area, the only single reflection extraneous energy reaching the quiet area results from edge effects at the relatively distant aperture. As shown by the ray traces in FIG. 1, the portion of the chamber between the aperture and the transmitter is contoured to minimize energy reflected into the aperture and back into the transmitter. In practice, 40 db absorbing material 34 is used around the transmitter side of the aperture 32 in order to minimize edge diffraction effects as far as possible. Nevertheless, the aperture design permits the use of 20 db absorbing material 36 on about 95 percent of the inner surface area of the chamber to yield a design performance figure of 40 to 50 db.

While FIG. 1 shows the smaller or transmitting end of the chamber contoured with rather complex transverse baffles, equivalent performance could be achieved by other baffle arrangements of appropriate design. Furthermore, the addition of longitudinal baffles to the larger receiving end of the chamber would assist in directing residual scattered energy away from the quiet area.

Referring now to FIG. 2, there is illustrated an anechoic chamber 40 of very long and narrow configuration wherein there is a quiet volume or zone 42 having the form of a truncated cone extending approximately 50 percent of the length of the entire chamber. The chamber comprises a tubular housing 44 of perhaps 400 feet in length measured from one end wall 46 to an opposite end wall 48. Typically, the housing 44 is annular in cross section with a diameter of approximately 10 feet. A microwave transmitter 50 is normally mounted in the center of the end wall 46 and aimed generally along the axis 52 of the chamber 40 towards the opposite end wall 48.

The transmitting end of the chamber is characterized by a cell 54 occupying approximately 130 feet of the chamber and terminating with an annular wall or flange 56, having formed centrally therein a circular aperture 58 (approximately 5 feet 4 inches in diameter). A series of baffles 60, 62 and 64 in the form of truncated conical shells are mounted on the inner surfaces of the cell 54 between the end wall 46 and the flange 56. These baffles, as well as the end wall 46 and the flange 56, have their inner surfaces covered with microwave absorbing material 66 of 20 db nominal reflectivity. The baffling, along with the absorbing material, serves to reduce reflection of energy both through the aperture 58 and back into the transmitter. It will be noted that the peripheral edges of the aperture 58 are turned outward as at 68 to minimize edge diffraction effects as far as possible.

Mounted about 35 feet from the end wall 48 is a second annular wall 70 parallel to the first and having a central circular aperture 72 of perhaps 2 feet in diameter. As in the first case, the peripheral edges of the aperture 72 are turned back as at 74 and a layer of 20 db absorbing material 76 is applied to the surface facing the transmitter. 20 db absorbing material 78 also lines the inner surface of the housing 40 from the annular wall 70 for a distance of about 145 feet towards the flange 56. The

remaining portion of the housing section of about 90 feet in length is not provided with absorbing material since the flange 56 prevents direct illumination of that portion of the housing. This feature is clearly shown in FIG. 2 by the ray paths 80 drawn from the transmitter 50 tangent to the edge of the aperture 58. It will be seen that by reason of the flange 56 such ray paths do not illuminate the uncovered section of the housing but will fall on that portion covered by the absorbing material 78. The relatively small flange 56 thus eliminates the need of covering a rather large proportion of the housing surface with absorbing material.

When the transmitter is energized, a free space zone, or quiet volume, having the configuration of a truncated cone, is produced between the annular walls 56 and 70 about the axis 52. This zone falls within converging lines 82 drawn tangent to the edges of the aperture 58 and 72 and intersecting at the end wall 48. A section of absorbing material 84 may be applied to this area of the wall to further reduce microwave reflections. There is no need to add absorbing material to the 35 foot section of the housing between the end wall 48 and the annular wall 70, since the latter completely precludes illumination of that area.

The conical free zone 42 has an over-all length of approximately 200 feet and has a rated performance figure in the 20 to 25 db range. Since this performance figure is relatively noncritical, the aperture design permits the complete elimination of absorbing material over a large portion of the chamber walls near the aperture 58 as shown, and insures operating performance somewhat better than the 20 db nominal reflectivity of the absorbing material used to cover most of the remaining surfaces. In view of the rather great length of the chamber, this reduction in the requirement of absorbing material represents a considerable savings in over-all cost while at the same time improving room performance.

In order to achieve a performance figure in excess of 25 db, several modifications of the FIG. 2 embodiment are possible. Absorbing material can be used to cover the entire inner surface of the chamber, suitable baffles can be added to the section of the chamber between the two annular baffles, and the aperture can be made the open end of a conical, spherical, pyramidal or other protruding section convex toward the quiet volume. An anechoic chamber of the sort described with its long free space is particularly suited for use with targets moving along the room axis. For instance, a target might be projected by suitable means along the axis and through the aperture 40 into the quiet volume.

While the invention has been described with particular reference to the illustrated embodiments, it will be obvious that a great many modifications may be made by those skilled in the art without departing from the invention.

Having thus described my invention, what I claim and desire to obtain by Letters Patent of the United States is:

1. A microwave anechoic chamber for housing means for propagating microwaves in one general direction, comprising a plurality of walls assembled to define an enclosure, including a transmitting portion and a receiving portion, said walls being formed with an inwardly projecting flange disposed transversely to said direction and defining a restricted opening disposed between said portions forming a relatively small transmitting portion and a relatively large receiving portion and preventing extraneous microwaves from passing from said transmitting portion to said receiving portion.

2. A microwave anechoic chamber according to claim 1, wherein the transmitting portion of the chamber is provided with baffle members to reduce the amount of microwaves reflected through said opening and back into the source of said microwaves.

3. A microwave anechoic chamber for housing means for propagating microwaves in one general direction, comprising a plurality of walls connected to define an elongated housing having a transmitting portion and a receiving

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ing portion, a flange mounted on said walls between said transmitting and receiving portions and projecting into said chamber transversely to said direction to form a relatively small transmitting portion and a relatively large receiving portion, said flange defining an aperture between said portions and being adapted to prevent extraneous energy from passing through said opening from said transmitting portion to provide a quiet volume of limited dimensions within said receiving portion.

4. A microwave anechoic chamber for housing means for propagating microwaves in one general direction, comprising an elongated housing oriented generally lengthwise of said direction and at least partially lined with microwave absorbing material of relatively low decibel performance, said housing being formed with a transverse restriction dividing said housing into a relatively small transmitting portion and a relatively large receiving portion, said restriction being effective to prevent extraneous microwaves from entering a quiet volume of relatively

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high decibel performance located within a receiving portion of said chamber.

5. A microwave anechoic chamber for housing means for propagating microwaves in one general direction, comprising a housing oriented generally lengthwise of said direction, a single transverse baffle mounted within said housing between the ends thereof to form a relatively small transmitting portion and a relatively large receiving portion and defining a restricted aperture effective to prevent extraneous microwaves from entering an elongated quiet volume located within the receiving portion of said housing and extending generally lengthwise thereof, the inner surfaces of said receiving portion being at least partially lined with microwave absorbing material.

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