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SEARCH ROOM

May 11, 1954

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2,678,393

RADAR SCANNING SYSTEM

Filed Sept. 30, 1950

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FIG. 1

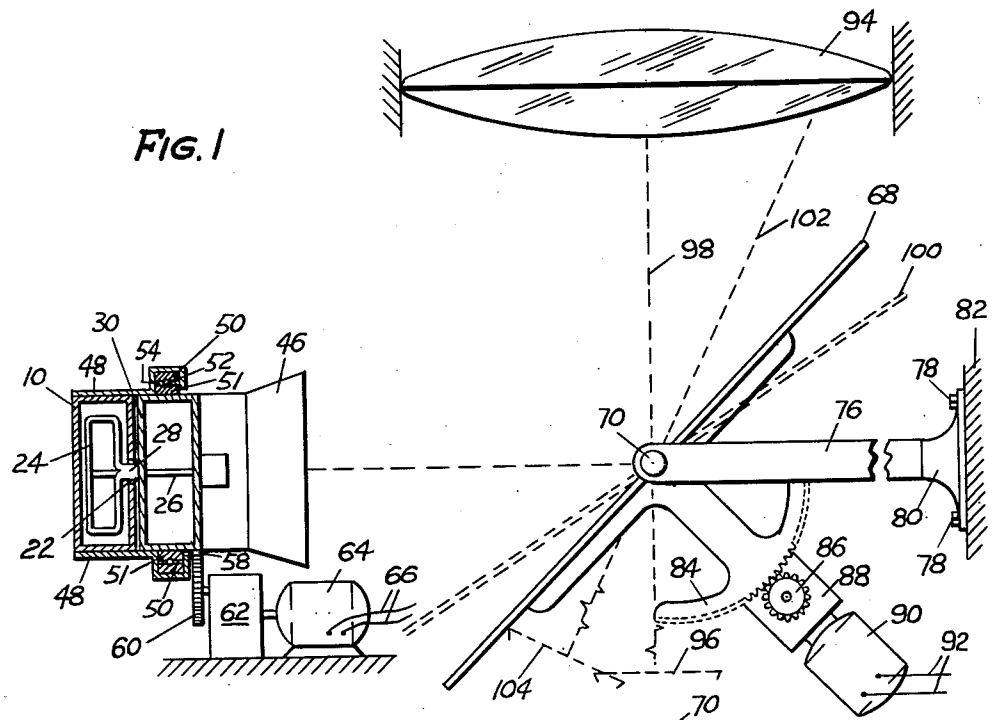
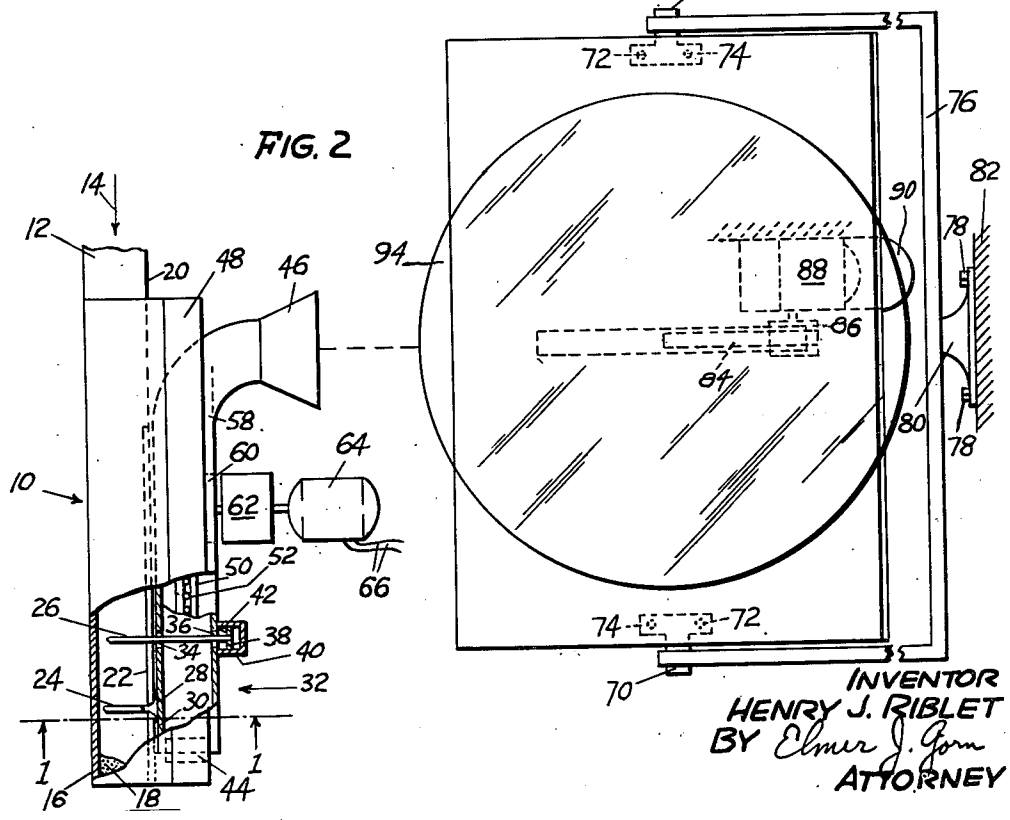


FIG. 2



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2,678,393

RADAR SCANNING SYSTEM

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Application September 30, 1950, Serial No. 187,803

9 Claims. (Cl. 250—33.65)

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This invention relates to radar scanning systems and more particularly to scanning systems using hollow rigid wave guides.

Where hollow rigid wave guides are used proper scanning becomes an important problem, particularly where movement of the horn or radiating element is required. Structural complications arise in achieving such freedom of movement without impairing the energy guiding characteristics of the wave guide. Because of these structural difficulties, the use of various joints have been generally resorted to. However, such joints present difficult problems in obtaining a suitable degree of scanning freedom. Pursuant to the present invention, freedom in scanning is achieved in rigid wave guide structures by providing a suitable wave guide radiator, such as a horn, as an independent unit movable with respect to the wave guide and coupling the horn by means of a probe to the wave guide so as to transmit the energy from the wave guide to the horn for directive radiation, and by inserting in the path of the radiated energy a fixed beam-shaping element, such as a lens or parabolic reflector. Movement of the horn with respect to the beam-shaping element thereby causes scanning of the shaped beam in a direction corresponding to the movement of the horn. By making the horn integral with a short wave guide segment arranged parallel to the wave guide, both mechanical structural arrangements for moving the horn and energy transfer coupling are greatly facilitated. In such case, the segment may be made to slide in guides fixed to the wave guide and may be suitably moved by a rack, pinion and motor arrangement. Energy transfer coupling may be achieved by providing a probe extending from the internal cavity of the wave guide, preferably in the direction parallel to the electric field, through an elongated slot in the side of the wave guide and through holes in opposite sides of the segment terminating in an adjustable plunger in a short-circuited stub on one side of the wave guide segment. The structure also preferably incorporates a reflecting loop in the cavity of the wave guide and terminating in a base portion in electrical contact with the segment, the loop being positioned with respect to the coupling probe in a manner to provide maximum transfer of energy through the probe to the segment. To minimize spurious reflections the wave guide may be terminated in an absorbent load, such as suitably bonded iron particles. The segment may also be terminated by an adjustable plunger positioned with respect to

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the probe for optimum operating characteristics. By providing a reflecting surface, such as a plate or screen for directing toward the beam-shaping element, the energy radiating from the horn and providing for angular rotation of the reflecting surface about an axis parallel to the direction of movement of the horn, scanning in a direction perpendicular to the horn is also achieved. Angular rotation of the reflecting surface may be obtained by a suitable pivotal structure, as a rotational axis with movement controlled by a gear, pinion and motor arrangement.

These and other features, advantages and objects of the invention will become more apparent from the following description taken in connection with the accompanying drawings illustrating an embodiment of the invention, wherein:

Fig. 1 is a schematic plan view of the embodiment of the invention with the wave guide and wave guide segment shown in cross section on line 1 of Fig. 2; and

Fig. 2 is a front elevation of the embodiment in Fig. 1 wherein only a portion of the wave guide is shown.

Referring to Figs. 1 and 2 in more detail, a portion of a wave guide 10, which is severed from the rest of the wave guide at the line 12 and of conventional rectangular rigid construction, has propagated therein in the direction of arrow 14 microwave radio energy from a suitable source, such as a magnetron (not shown). The end 16 of the wave guide 10 is preferably sealed with an energy absorbent load 18, which may consist of suitable bonded iron particles or the like. The wave guide 10 is provided at its side 20 with a long, narrow slot 22 preferably dimensioned and positioned for minimum loss of energy and through which projects an energy reflecting loop 24 and a coupling probe 26. The reflecting loop 24 may be of conventional design shaped for resonance at the frequency in the wave guide with its base 28 in electrical contact with side 30 of a wave guide segment 32, as by silver soldering of base 28 to side 30. The reflecting loop 24 is positioned with respect to probe 26 so as to cause maximum energy transfer from the wave guide 10 through the coupling probe 26 to the wave guide segment 32. The coupling probe 26 extends through holes 34 and 36 in the opposite sides of the wave guide segment 32 and terminates in a movable plug 38 in a short-circuited stub 40. The plug 38 is adjusted for a cavity 42 in the stub 40 for proper reactance matching of the coupling elements. A movable plunger 44 may also be provided at one end of

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the wave guide segment 32 for impedance matching. The other end of the wave guide segment 32 has preferably a right angle bend therein which terminates in a horn 46. The wave guide segment 32 with its horn 46 is mounted to move in a direction parallel to the wave guide 10. A suitable mounting arrangement for this purpose may consist of guide brackets 48 attached at one side to the opposite sides of wave guide 10, as by brazing, and guide runners 50 and 51 between which are ball bearings 52 confined by a retainer 54. The guide runners 50 are fixed to guide brackets 48, and guide runners 51 are fixed to segment 32. A suitable rack 58 fixed to one side of the wave guide segment 32 has engaged therein a pinion 60 operated from a conventional reducing gear mechanism 62 powered from an electric motor 64 connected to a suitable control element and potential source (not shown) by lines 66.

The horn 46 is directed toward a radio energy reflecting surface 68, such as a plate or screen, which is mounted for angular movement about pivots 70 mounted at either end of the reflecting surface 68, as by screws and brackets 72 and 74, respectively. The pivots 70 are rotatably arranged in a yoke member 76 fixed as by screws 78 at a base portion 80 to a rigid surface, such as a wall 82. Angular rotation of reflecting surface 68 about the pivot 70 is effected through a gear segment 84 fixed to the back side of the reflecting surface 68 and having the pivot 70 as an axis. Gear segment 84 is driven by a pinion 86 operated through a reducing gear mechanism 88 by electric motor 90 controlled through lines 92 leading to a suitable control and power source (not shown). The angle of the reflecting surface 68 is such that radio energy radiation from the horn 46 will be reflected by the reflecting surface 68 through a beam-shaping element, such as lens 94.

In operation, radio energy in the wave guide 10 is picked up by the coupling probe 26 and propagated in the wave guide segment 32. From the wave guide segment 32 the propagated radio energy is radiated from the horn 46 toward the reflecting surface 68 from whence it is reflected through the lens 94. Scanning in the plane of the paper in Fig. 1 is obtained by rotation of the reflecting surface 68. Thus when the reflecting surface 68 is in the position shown in Fig. 1, the general travel of the radio energy will be perpendicular to the lens 94, making the horn 46 appear as an image source 96 behind the reflecting surface 68 in line with the direction 98 of reflected rays through the lens 94. If, for example, the reflecting surface 68 is rotated in a clockwise direction to the position shown by dotted lines 100, the reflected rays will be in a direction shown by line 102 and the horn will appear as an image from an imaginary source at 104. Thus it is seen that, as the reflecting surface 68 is rotated in one or the other direction, it results in an apparent movement of the horn or radiation source. This apparent movement of the horn or radiation source thereby causes a corresponding movement of the shaped beam emanating from the lens 94 and results in scanning in accordance with this movement in the plane of the paper in Fig. 1.

For scanning in a plane perpendicular to that just described with regard to Fig. 1, or in the plane of the paper shown in Fig. 2, the horn, itself, is moved along with segment 32 by means of the rack 58, pinion 60, reducing gear 62, and

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motor 64. Thus three dimensional scanning is achieved.

This invention is not limited to the particular details of construction herein described, since equivalents will suggest themselves to those skilled in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. A scanning system comprising a rectangular hollow rigid wave guide, a wave guide segment disposed to move in parallel relation to said wave guide, a slot in one side of said wave guide, microwave energy coupling means extending from said segment through said slot into said wave guide, a horn at one end of said segment for radiating microwave energy, beam-shaping means, and a movable reflecting means disposed to direct said radiated energy at said beam-shaping means.

2. A scanning system comprising a rectangular hollow rigid wave guide, a wave guide segment disposed to move in parallel relation to said wave guide, a slot in one side of said wave guide, microwave energy coupling means extending from said segment at said slot into said wave guide, a horn at one end of said segment for radiating microwave energy, fixed beam-shaping means, and an angularly movable reflecting means disposed to direct said radiated energy at said beam-shaping means.

3. A scanning system comprising a rectangular hollow rigid wave guide, a wave guide segment disposed to move in parallel relation to said wave guide, a slot in one side of said wave guide, microwave energy coupling means extending from said segment through said slot into said wave guide, a horn at one end of said segment for radiating microwave energy, beam-shaping means, a reflecting means disposed to direct said radiated energy at said beam-shaping means, and means for angular rotation of said reflecting means, the axis of said rotation being substantially parallel to the direction of motion of said wave guide segment.

4. A scanning system comprising a source of energy, a radiating horn coupled to said source of energy and disposed to move along a first path, a beam-shaping means, and an angularly movable energy reflecting means positioned to direct energy radiated from said horn at said beam-shaping means along a second path perpendicular to said first path.

5. A scanning system comprising a wave guide, a radiating horn coupled to said wave guide and disposed to move in parallel relation thereto, a beam-shaping means, and an angularly movable energy reflecting means positioned to direct energy radiated from said horn at said beam-shaping means.

6. A scanning system comprising a source of energy, an electromagnetic horn coupled to said source of energy and adapted to be moved along a first path, a reflector positioned to intercept microwave energy radiated from said horn, means for rotating said reflector about an axis parallel to said first path, a beam-shaping element, said reflector being disposed to direct said intercepted energy at said beam-shaping element along a second path perpendicular to said first path.

7. A scanning system comprising a wave guide, an electromagnetic horn coupled to said wave guide and adapted to be moved along the longitudinal axis thereof, a reflector positioned to intercept microwave energy radiated from said

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horn, means for rotating said reflector about an axis parallel to said first path, a beam-shaping element, said reflecting means being disposed to direct said intercepted energy at said beam-shaping element.

8. A scanning system for scanning in two directions perpendicular to each other comprising a wave guide for transmission of energy along the longitudinal axis thereof, a horn coupled to said wave guide and capable of radiating a portion of said energy, a beam-shaping element, a reflecting means disposed to direct energy radiated from said horn toward said beam-shaping means, means for moving said horn along said wave guide parallel to the longitudinal axis thereof for effecting the scanning of said shaped beam in a direction corresponding to the movement of said horn, means for producing angular rotation of said reflecting means about an axis parallel to the direction of movement of said horn for effecting scanning of said shaped beam in a direction perpendicular to said direction of movement of said horn.

9. A scanning system for scanning in two directions perpendicular to each other at different rates comprising a wave guide for transmission of energy along the longitudinal axis thereof, a horn coupled to said wave guide and capable of radiating a portion of said energy, a beam-shap-

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ing element, a reflecting means disposed to direct energy radiated from said horn toward said beam-shaping means, means for moving said horn at a first rate along said wave guide parallel to the longitudinal axis thereof for effecting the scanning of said shaped beam at said first rate in a direction corresponding to the movement of said horn, means for producing angular rotation of said reflecting means at a second rate about an axis parallel to the direction of movement of said horn for effecting scanning at said second rate in a direction perpendicular to said direction of said movement of said horn.

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