

Nov. 4, 1952

J. T. BOLLJAHN  
ELECTROMAGNETIC RADIATOR

2,617,031

Filed Dec. 6, 1944

FIG. 1

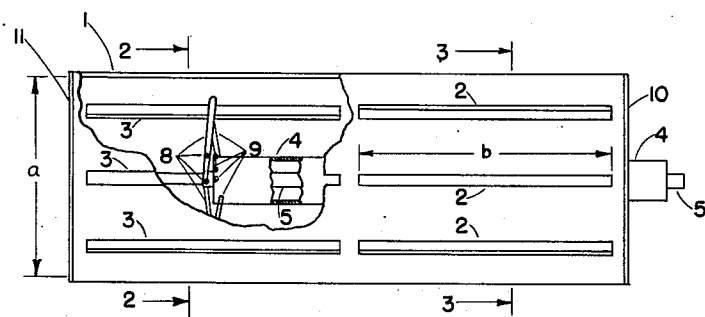


FIG. 2

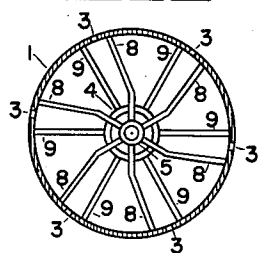
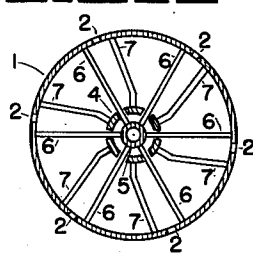


FIG. 3



Inventor  
JOHN T. BOLLJAHN

By

*J. E. Bush*

Attorney

## UNITED STATES PATENT OFFICE

2,617,031

## ELECTROMAGNETIC RADIATOR

John T. Bolljahn, Washington, D. C.

Application December 6, 1944, Serial No. 566,938

1 Claim. (Cl. 250—33.63)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

1

This invention relates to the construction of radiators for electromagnetic transmission and is particularly directed to the problem of maintaining the desired operating characteristics with decreased physical size of the structure.

The radiator of the present invention is of the type in which an array of slots defined by apertures in a cylindrical member is employed to yield an omnidirectional field strength pattern circumferentially of the cylinder, and a somewhat compressed single lobe pattern in a longitudinal plane passing through the axis of the cylinder.

The invention is particularly intended for use in applications where small physical size of the radiator is of primary importance, as in aircraft installations.

The invention will be further described with reference to the exemplary embodiment shown in the drawings, in which

Fig. 1 shows an antenna of the present invention partly broken away to show the internal construction.

Fig. 2 shows a section on the line 2—2 of Fig. 1.

Fig. 3 shows a section on the line 3—3 of Fig. 1.

In the embodiment shown in Fig. 1, the radiating structure is formed by conducting tube 1 apertured to form two series of slots, 2 and 3. Six slots at equal angular spacing are provided in each series, all slots being of the same dimensions, their length being substantially a half wave long.

As will be understood, the slots are excited medially on each longitudinal edge and constitute radiating elements. The circular array gives a pancake-type beam whose sharpness is increased by employing the two series of slots to give a double array.

Such an array has been proposed wherein the slots are cut in a wave guide carrying  $TE_{01}$  radiation, the field within the guide being distorted asymmetrically at each slot by conductors extending inwardly of the guide medially of each slot wall. The diameter of the radiator is determined by the wavelengths of the radiation, however, due to the fact that  $TE_{01}$  excitation is required the guide cannot be smaller than  $1.2195\lambda$ , where  $\lambda$  is the operating wavelength.

It has been found that such a large diameter is unnecessary to secure the desired directional characteristics of the radiated field pattern, and that a structure of much smaller cross-section

2

may be employed when the slots are energized from an internal transmission line which is free of the cutoff transmission characteristic of a waveguide. By employing such a line, it is possible to reduce the size of the radiating structure to a fraction of that of the aforementioned antenna, with attendant reduction in its drag for aircraft installation.

In the embodiment shown in the drawing, the radiator is energized by an internal coaxial line comprising an outer member 4 and inner member 5. The line is connected to the radiator by two series of conductors 6 and 7 for energizing slots 2 as shown in Fig. 3, outer conductor 4 being perforated where the conductors 6 pass from the inner member to the radiating slots.

Where a plurality of arrays of radiators are employed they may be driven in phase by tapping the connections onto the internal line at points substantially a half wave length apart, the line components being connected to the opposite side of the slots in adjacent series. Thus, the connections for driving the two series 2 and 3 of slots shown in Fig. 1 are connected to the coaxial line at half wave points, and as shown in Fig. 2, the connectors 8 and 9 connect slots 3 reversely to the line with reference to the connections shown in Fig. 3. The connections to points of inverse phase on the transmission line, with the reverse connection to the radiating elements, established in-phase excitation of the arrays.

Slots 3 being the end array, it is convenient to extend the inner conductor 5 beyond the end of conductor 4 for facilitating attaching connectors 8. Connectors 9 are attached to outer conductor 4.

From the discussion above, it will be understood that the diameter  $a$  of the antenna may be much less than  $1.2195\lambda$ , or 2.439 times the length  $b$  of a half wave slot. In the embodiment shown, the diameter  $a$  is less than one third of that required for wave guide energization of the radiating elements, e. g. less than  $.4065\lambda$ .

In the embodiment shown, six spaced slots are employed in each series. This or a greater number may be used to give a substantially uniform circular pattern, although a less number may be employed if such uniformity is not required.

The invention described herein may be manufactured and used by or for the Government of

3

the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

An omnidirectional slot type radiator structure 5  
consisting of a cylindrical conductive sheet slot-  
ted longitudinally to define an array of parallel  
circumferentially spaced radiating elements hav-  
ing a length substantially that of a half wave at  
the operating frequency of the radiator structure,  
the inner diameter being less than .4065 the said  
wave length, a main two conductor line extending  
axially along the center of the cylinder, and radi-  
ally extending connectors branching from the  
main line conductors at adjacent locations and 10  
terminating electrically at the inner surface of  
the cylinder at each longitudinal side of each  
slot centrally of its length, whereby the radiators

4

of the array are connected in parallel across the  
main line.

JOHN T. BOLLJAHN.

#### REFERENCES CITED

The following references are of record in the  
file of this patent:

#### UNITED STATES PATENTS

| 10 | Number    | Name         | Date          |
|----|-----------|--------------|---------------|
|    | 2,234,293 | Usselman     | Mar. 11, 1941 |
|    | 2,238,770 | Blumlein     | Apr. 15, 1941 |
|    | 2,250,096 | Engbert      | July 22, 1941 |
|    | 2,400,867 | Lindenblad   | May 21, 1946  |
| 15 | 2,407,068 | Fiske et al. | Sept. 3, 1946 |
|    | 2,408,435 | Mason        | Oct. 1, 1946  |
|    | 2,414,266 | Lindenblad   | Jan. 14, 1947 |