18. *Projector of the Sharpest Beam of Electric Waves.*

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Suppose that a vertical antenna is sending out electro magnetic wave in all directions around it. If a straight metallic rod of finite length be vertically erected within the field of its propagation, then the behavior of this metal rod will be as follows :—

When the length of this rod is equal to or slightly longer than a half wave length, the current induced in it will be in phase with or lagging behind the E.M.F. caused by the electric wave, and the rod will act as a "Wave reflector."

If, on the other hand, the length be made somewhat less than a half wave length, the current induced in it will be leading before the E. M. F., and the rod will act as a "Wave director".

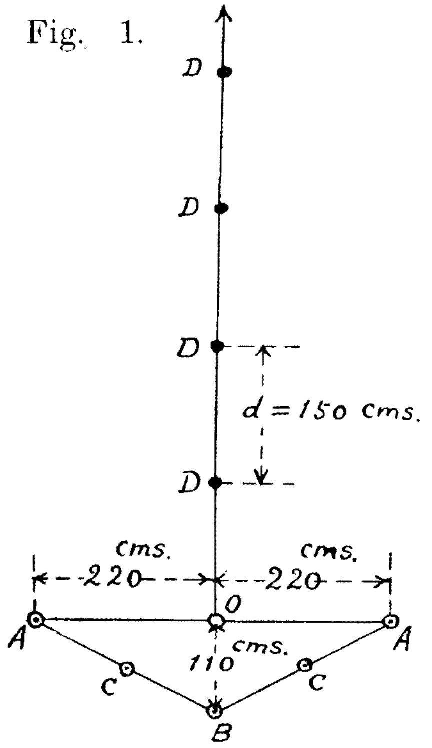
A single wave reflector placed behind a radiating antenna is sufficient to cause directive radiation of radio wave. It is especially efficient when placed a quarter wave length behind the radiating antenna. Again a wave director placed in front of and more than a quarter wave length distant from the radiating antenna is also effective in producing a directive radio wave.

When several wave director rods are arranged along a line with intervals equal to or more than a quarter wave length, the wave energy will be projected chiefly along this line, and the series of these wave directors forms what the authors will call a "Wave duct" or a "Wave canal".

According to the authors' experience, a parabolic reflector is not necessary for producing a beam of radio wave. The simplest and comparatively effective reflector may be formed as stated below.

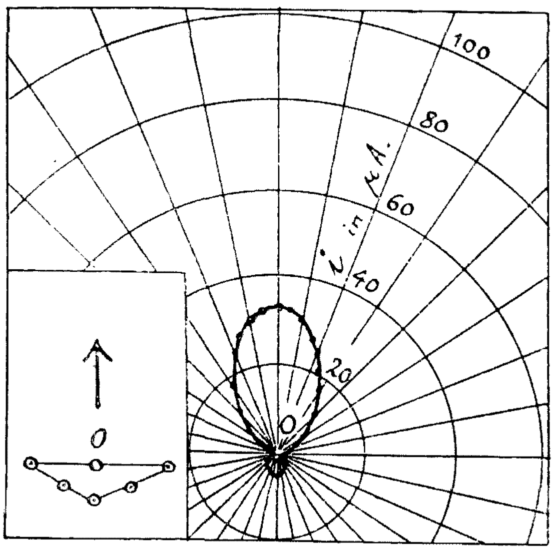
A wave reflector rod is placed a quarter wave behind the antenna and two more wave reflectors, one being on the left and the other on the right side of it, are placed a half wave distant from the antenna. (Fig. 1.) These three rods form a tri-antennary reflecting system which will hereafter be called a fundamental "Trigonal reflector".

Fig. 1.



Wave length $\lambda = 400$ cs.
0 ......Sending or receiving antenna
A......Side reflectors
B......Back reflector
C......Screening reflectors
D......Wave directors
◉......Brass rod, 220 cms. long
●......Brass rod, 180 cms. long

Fig. 2.



Trigonal reflector with 5 rods.
Wave length = 440 cms.
Length of reflector rod = 220 cms.

Two more reflector rods C C are shown in Fig. 1. These are not as efficient as a reflector as A and B's, but their existence enables closer screening of waves in the backward direction, and when this reflector system is employed in a receiving station, they are specially effective to eliminate external disturbances from behind.

Combined with these screening rods, the trigonal reflector is now formed of five rods. The position of the screening rods are nearly midway between A nd B, and a slight variation of their position is practically ineffectual.

When the trigonal reflector is employed in a receiving station, it may better be called a " Trigonal collector ".

Now the projection of the sharpest beam ever produced of electric waves can be effected by the combination of a trigonal reflector and a wave duct. This combination will thus be called a "Wave projector." It is also very advantageous to employ a wave duct and a trigonal collector at receiving stations.

The directivity can be improved by increasing the number of wave director rods contained in the wave duct. As an extreme case, when the sending and the receiving stations are connected with a line of wave canal, the transmission of wave energy can be the most efficaciously accomplished.

Some typical results of observation with short electric wave are given below. Fig. 1. shows the plan view of the arrangement of conductors for the wave length

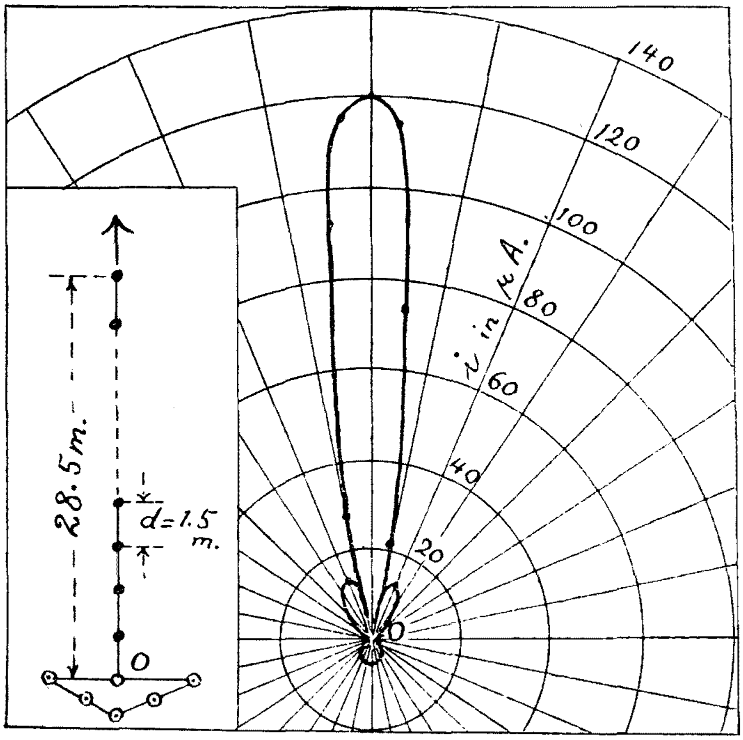


Fig. 3.

Wave projector.

Wave length = 400 cms.

◉ 5 rods, 220 cms. long

● 19 rods, 180 cms, long

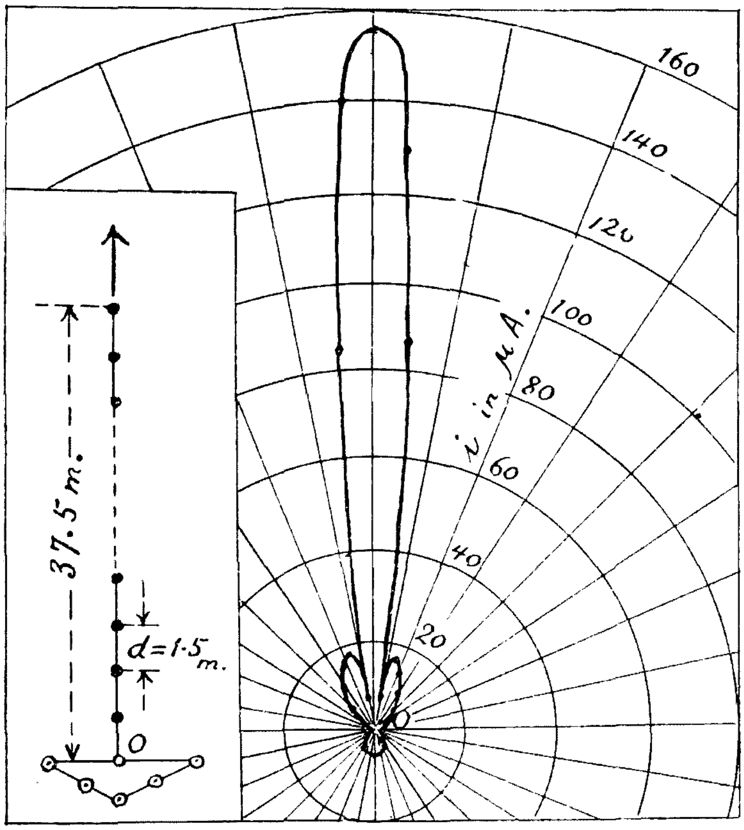


Fig. 4.

Wave projector.

Wave length = 400 cms.

◉ 5 rods, 220 cms. long

● 24 rods, 180 cms. long

of 4.4 metres.

In Fig. 2. is shown the directive effect of a trigonal reflector with five rods. No wave director is here employed, and the intensity is measured with a receiving system comprising a crystal detector and a galvanometer. It has been very carefully ascertained that this crystal system gives tde most consistent results throughout the long time of experiments.

In Figs. 2. 3. and 4., the radius vector of the polar diagram gives the measure of intensity in the receiving system placed in that direction, the distance from the sending station being kept constant.

Now if the wave duct or wave canal is provided, the directivity becomes remarkably augmented. In the case of Fig. 3., 19 rods of 180 cms. length (a half wave being equal to 220 cms.) were arranged along a line with interval of 150 cms. (a quarter wave being equal to 110 cms.). In the case of Fig. 4., 25 rods of 180 cms. length were set up with interval of 150 cms. The length of all the reflector rods was made equal to the half wave length, i.e. 200 cms.

The field measurements were made under the same conditions, and the short wave generator was also kept at exactly the same condition for all the observations of Fig. 2., Fig. 3. and Fig. 4.

It is easy to explain how the radiation in the side direction becomes minimum, and the polar diagrams prove the realization of the sharpest beam ever produced of electric waves.

Many observations of various cases have been made in the Tohoku Imperial University, Sendai, and further details will in time be published in the Journal of the Institute of Electrical Engineers of Japan.