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containing essentially the same material and particularly of book reviews in different periodicals, and to abstract serial articles as a whole rather than in their individual parts. An abstract service should effectively provide the user with a key to the information contained in the subject. The staff available for abstracting services are bound to be handicapped by inadequate training and lack of experience in the fields of modern scientific research and applications. This limitation, as well as a shortage of paper, makes a too comprehensive abstracting service impracticable. Instead, it should be a critically selective service, drawing attention to the most important publications as soon as these become available.

It is seriously suggested that the present scope of the "Abstracts and References," as published in the PROCEEDINGS, represents a reasonable compromise between a mere catalogue of references to every paper published in every journal and a series of reviews of progress in special fields of the type now being published from time to time in various countries.

I am indebted to Mr. J. W. Head, who was formerly in charge of the abstracting section of the Radio Research Organization, and to Mrs. D. Loman, who has succeeded him, for some of the information and opinions expressed in this letter.

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Polarization Errors of Radio Direction Finders, A Proposed Classification*

INTRODUCTION

Radio direction finders and rotating-pattern navigation systems are generally designed to receive and transmit waves of a single linear polarization. For example, all high-frequency direction finders in use today are designed to receive vertically polarized waves and vhf omniranges are designed to transmit horizontally polarized waves. Variable errors of indication are obtained with both receiving direction finders and navigation systems whenever the polarization of the received wave changes. The terms "night effect," "airplane effect," "polarization effect," and more commonly, simply "polarization error" have been used in discussing the bearing changes and errors which accompany changes in the polarization of a received wave.

A direction-finding system designed for vertically polarized waves will, in general, produce either no bearing at all or an incorrect bearing, when the received wave is purely horizontally polarized. The fault, however, resides in the direction finder, and not in the horizontally polarized wave component. The vertically polarized wave component is "wanted" and the horizontally polarized component is "unwanted," simply because the direction finder is calibrated or oriented for vertical polarization, and does not respond with equal amplitude and with a consistent directivity to all polarizations.

A received wave component is always "wanted" if the direction-finder antenna responds strongly to it with a directivity pattern oriented in agreement with the initial scale calibration of the indicator. Any wave component which excites either a weak response or which excites a differently oriented response is likely to produce errors and is therefore "unwanted."

PROPOSED CLASSIFICATION

The classification of polarization errors proposed here is based on the thesis that all polarization errors result from instrumental faults or deficiencies, and that a wave component is "unwanted" only when the instrument either exhibits no response at all, or when it exhibits an incorrectly oriented pattern of directivity.

Errors of the first proposed class result from an inherent strong response to an "unwanted" wave component.

Errors of the second proposed class result because the instrument fails to respond to a primary wave component and takes a bearing on a parasitic re-radiator instead of on the true source.

A. Primary Instrumental Polarization Errors

A direction finder with either a loop antenna or an elevated U-Adcock antenna will exhibit a 90-degree bearing error if the received wave is purely horizontally polarized. (Ideally, the loop will produce no bearing at all unless the horizontally polarized wave has a down-coming component.) If the wave has mixed polarization, the bearings may be definite or indefinite and the error may vary between zero and 90 degrees.

The polarization error in this case is due to an inherent response of the antenna to an "unwanted" primary component of the received wave, and exists regardless of the excellence of the instrument and of the site on which it is installed.

It is proposed that such an error be called a "primary instrumental polarization error."

B. Secondary Polarization Errors

A vertically polarized spaced-collector direction finder having a low inherent primary polarization error will sometimes exhibit large errors when the received wave is strong and almost purely horizontally polarized. This situation arises from the presence at the direction finder of vertically polarized secondary fields.

A secondary field might, for example, be received from an oblique conductor in the vicinity which has abstracted energy from the strong horizontally polarized primary component and re-radiated a vertically polarized secondary component. The bearing errors indicated when such a secondary field is received might be termed "secondary polarization errors," or "polarization-sensitive site errors."

The conductors forming part of a direction finder may also serve as parasitic sources of secondary fields which produce varying errors as the polarization of the primary field changes. The latter errors are due to instrumental faults which could be corrected and might be termed "secondary instrumental polarization errors."

The importance of secondary polarization errors is very great in the case of both receiving direction finders and navigation systems. This importance comes about not because the secondary fields in themselves are of large magnitude, but rather because the response of the receiving antenna to the primary field is either zero or very small. This suggests that the proper approach to a solution of the secondary polarization error problem is to insure that the receiving antenna is capable of responding strongly and with correctly oriented directivity to the primary field, regardless of its polarization. When the response to the primary wave is large, "unwanted pickup" of the secondary field is usually too small by comparison to affect accuracy of direction finding.

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A Short Proof that an Isotropic Antenna Is Impossible*

Brouwer[1] has proved that for the usual spherical coordinate system it is impossible to find a vector function $\boldsymbol{A}(\theta, \phi)$ which is a continuous function of (θ, ϕ), and has the properties that $\boldsymbol{A} \cdot \boldsymbol{r} = 0$ and $A \neq 0$ for all values of (θ, ϕ).

Consider a radiating antenna located at the origin of a spherical co-ordinate system. At a great distance from the antenna the electric field intensity due to the antenna can be expressed in the form

$$\boldsymbol{E} = \frac{1}{r}\left[E_\theta(\theta, \phi) \sin(\omega t - \beta r + \gamma)\boldsymbol{u}_\theta + E_\phi(\theta, \phi) \sin(\omega t - \beta r + \delta)\boldsymbol{u}_\phi\right],$$

where $\boldsymbol{u}_\theta$ and $\boldsymbol{u}_\phi$ are unit vectors in the θ and ϕ directions, respectively, and $\beta = 2\pi/\lambda$. According to the above theorem $E_\theta(\theta, \phi)$ must be zero for some value (θ_0, ϕ_0) of (θ, ϕ) since $\sin(\omega t - \beta r + \gamma) \not\equiv 0$. Consequently there is no radiation in the (θ_0, ϕ_0) direction with θ-polarization. Thus an antenna that radiates uniformly in every direction and polarization is impossible. Since a radiating isotropic antenna is impossible, a receiving isotropic antenna is also impossible according to the reciprocity theorem for antennas.

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[1] L. E. J. Brouwer, "Over continue vectordistributies op oppervlakken," *Proc., Koninklijke Akademie van Wetenschappen* (Amsterdam), vol. 11, pp. 850–858; 1909.