Edouard Labin (A'42–SM'46), a French radio engineer, was born in Bucharest, on March 11, 1910. He received the degree of bachelor of science and philosophy in Paris in 1928, was graduated as Licencié es Sciences Physiques from the Sorbonne, Paris, in 1933, and as radio-engineer from the École Supérieure d'Electricité, Paris, in 1935. He then became associated with advance research in the field of radio, electronics, and radio aids to navigation.

From 1936 to 1937, Mr. Labin was engaged as research engineer in the radio laboratory of the Lignes Télégraphique et Téléphoniques company near Paris, and from 1938 to 1939 he headed a development department of the Laboratoires Radioélectriques Co. in Paris. With the beginning of war in September, 1939, he served with the French Air Force, and after the French Armistice, worked for nine months with the Lyon group of the Company L.M.T

Edouard Labin

From 1941 to 1946, Mr. Labin was on the staff of the Buenos Aires branch of the Societé Anonyme Philips as assistant chief and, later, chief engineer of the Radio Research Laboratory. In the Argentine University in Buenos Aires, he was professor of general radioelectricity and assistant professor of mathematical theories applied to radio.

In 1947 Mr. Labin returned to France where he became chief of the Laboratory for Electronics and Applied Scientific Research of the Philips organization in Paris. His main work in radio pertains to radio aids to navigation, transmission, general theory of circuits, and frequency modulation; and, in electronics, to production, maintenance, and special uses of electron beams.

Mr. Labin is the author of numerous studies, papers, and patents in various branches of radio, and allied fields.

Correspondence

Note on Practical Limitations in the Directivity of Antennas*

Mr. Riblet's paper[1] indicates the possibility of increasing the directivity by properly controlling the current distribution of an antenna. He has presented an analytical theory which indicates that directivity can be increased almost indefinitely, even though the antenna is limited in dimensions.

In 1930, I studied that particular problem without using the integral equations that are involved, but by considering discrete antenna elements and adding elements which, by trial and error, I found increased the directivity. After a comparatively short experience, the selection of the discrete elements to increase directivity became a comparatively simple matter, so that the amount of work involved was not nearly so burdensome as appeared necessary at the first attempt. I was able to design an antenna within 1 wavelength that had a directivity comparable to an antenna of some 10 wavelengths long. This result clearly appeared impractical. I therefore began to study the effective radiation resistance of these antennas, and found, to my distress, that the radiation resistance fell off very rapidly. In the case of one of the antennas that I had designed in this way, I calculated an effective radiation resistance of the order of 10^{-6} ohms. Clearly, such an antenna would have high directivity, but would radiate practically no power. All the power would be dissipated in ohmic resistance. Continuing this study, I discovered that if the directivity is increased beyond that which would be obtained by a simple design with individual radiators in phase, the radiation resistance at first remains fairly steady, but when the directivity is increased beyond a certain point it begins to fall off extremely rapidly. It is only by reducing the ohmic resistance that such increased directivity can be effectively used, and in practice it is not possible to increase the directivity without soon reaching the stage where the radiation resistance is too low for practical purposes.

In the case of certain broadcast antennas, I have presented evidence during the 1930's at hearings before the Federal Communications Commission showing that certain directional antennas were likely to have a much lower efficiency than expected because their directivity was too great for the space in which they were laid. That general result has been found by designers of directional antennas. The physical explanation of this phenomenon is to be found in the increase of circulating currents as the directivity is increased, thereby increasing the ohmic loss and the effective ohmic resistance.

An obvious and well-known case of a directional antenna contained in a small space is the loop antenna. This antenna consists effectively of two radiators spaced a small fraction of a wavelength apart with their currents almost exactly out of phase. It is well known that such an antenna for the space that it takes has a comparatively high directivity, its directional pattern being a figure of eight. The reason that such a system is practicable is because, although it carries a large circulating current, the ohmic resistance in the path of the circulating current is very low, so that the small radiation resistance of the system is still adequate to produce, in some cases, a reasonable degree of efficiency.

In an effort to improve the efficiency and characteristics of broadcast antennas by controlling the current distribution along a radiator, I developed a radiator[2] which was effectively excited at both its ends. In a vertical radiator the top-end excitation was obtained by means of an insulated top loading. By adjusting the ratio of the excitation at the two ends of the radiator, it is possible to control to any reasonable extent the current distribution along the radiator. By this means the directivity in the plane of the radiator can be controlled. If the coupling circuit is adjusted so that the directivity is increased and the radiation resistance reduced, a point is reached at which the efficiency, or rather the effective field in the horizontal plane, is a maximum for a given power input. That condition is one that is commonly desired by broadcast stations. This maximum value depends on the ohmic loss of the antenna and coupling circuits. The lower the ohmic loss, the greater the directivity obtainable without excessive loss of radiation efficiency. An interesting point is that, quite frequently, increasing directivity reduces the ohmic loss by reducing the ground currents, as will occur in a vertical antenna when the required excitation decreases the current at the base.

Another possible practical use of this doubly excited vertical antenna is to adjust the directivity so that the minimum radiation occurs at such an angle that the sky wave at that angle corresponds with the normal beginning of the rapid-fading zone. The rapid-fading zone can therefore be pushed back so that the effective primary service of a regular broadcast station can thereby be increased.

It appears that the control of directivity which Mr. Riblet suggests as being possible in his paper has some practical applications, but there are strict limitations to the degree to which increased directivity can be obtained without building up the losses of the system beyond values which make the operation impracticable.

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* Received by the Institute, May 14, 1948.

[1] H. J. Riblet, "Note on the maximum directivity of an antenna," Proc. I.R.E., vol. 36, pp. 620–624; May, 1948.

[2] U. S. Patent Nos. 2,283,617, 2,283,618, and 2,283,619.

Upper-Atmosphere Circulation as Indicated by Drifting and Dissipation of Intense Sporadic-*E* Clouds*

Knowledge of upper-atmosphere circulation in the region 80–120 km. in altitude has been limited to the meager data obtained from observations of meteor trains[1–3] and luminous night clouds.[4–6] Mimno[7] and Eyfrig[8] have observed measurable time differences in the appearance overhead of sporadic-*E* clouds of very high ionized densities between geographic locations separated from one to fifty miles. The limited size of these clouds which appear to be immersed in the *E*-region of the ionosphere is known.[7–10] The writer[11] has proposed that an analysis of a large number of medium-duration radio transmissions in the frequency band 50–60 Mc. may provide additional information on the apparent drift of sporadic-*E* clouds.

A co-operative research program was initiated by the writer in 1947 to study the effects of sporadic-*E* reflections in the radio amateur band 50–54 Mc. Normally, radio wave transmissions at these frequencies are limited by the curvature of the earth. Occasionally, the appearance of highly ionized sporadic-*E* clouds will propagate radio signals at these frequencies to distances of 400 to 1400 miles. The random distribution and operating hours of radio amateurs throughout the United States and Canada has permitted the frequency of occurrence of sporadic-*E* clouds to be determined with a fair degree of accuracy.

The times, dates, and duration of reception or two-way communication when 50-Mc. signals were propagated beyond skip-distance ranges of 400 miles were tabulated. Arbitrary periods of approximately 30 minutes duration were then established. The equivalent free-electron density to refract a mean radio frequency of 50.25 Mc. back to earth is then calculated from the path length between radio stations. Assuming great-circle transmission with no horizontal deviation, the midpoint will represent the point of reflection overhead in the *E*-region. Plotting a large number of paths within the prescribed period enables the size and horizontal ionization gradient of the sporadic-*E* cloud to be determined.

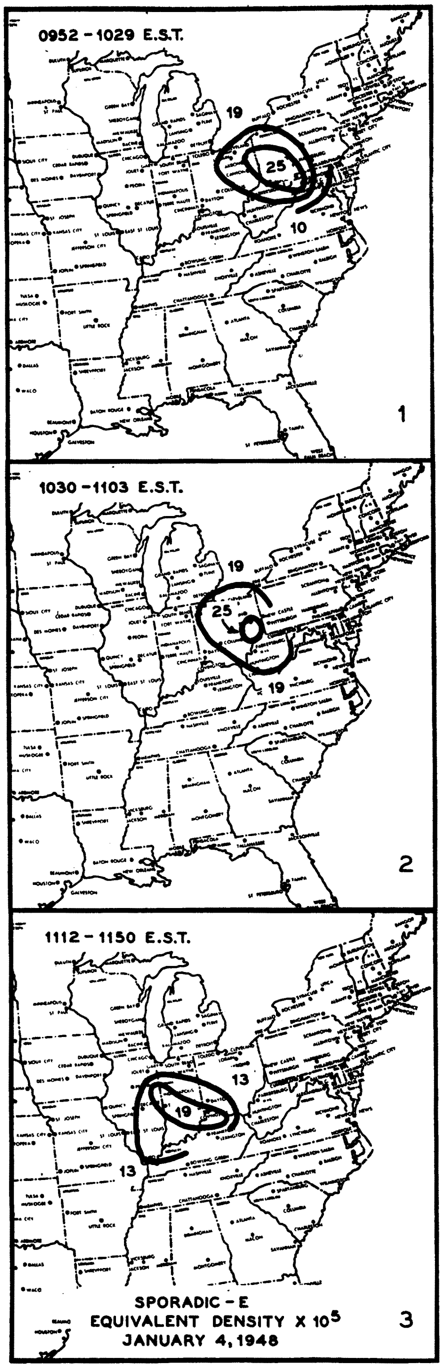
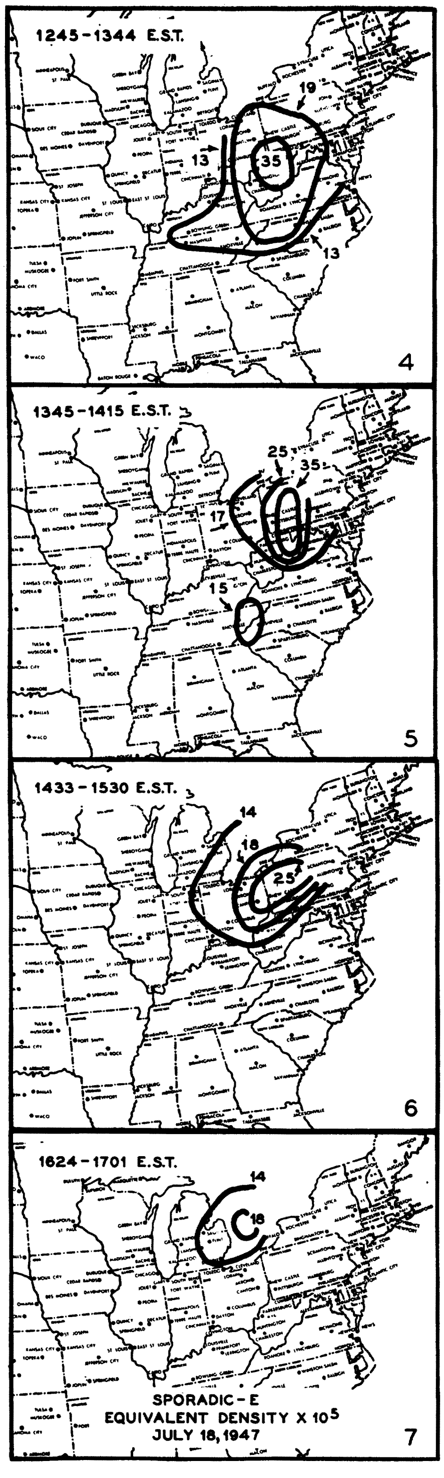


Fig. 1–3



Figs. 4–7

Fig. 1 illustrates the area overhead and the approximate density of the sporadic-*E* cloud occurring the morning of January 4, 1948. The method described does not permit a fine-structure analysis of the cloud. However, the equivalent density at the center of the cloud probably exceeded 40×10^5 free electrons/cm³. This was derived from path lengths of the order of 440 to 480 miles at a frequency of 50.25 Mc. Contours of equal density are drawn to encompass scattered points of reflection. The density contour 10×10^5 is based upon the vertical-incidence measurements of the sporadic-*E* cloud made at Washington, D. C.[12]

Fig. 2 shows the position and relative density approximately 30 minutes later than Fig. 1. It will be immediately noted that a drift of the sporadic-*E* cloud has occurred. During the 1030–1103 E.S.T. period the highest required equivalent density did not exceed 26×10^5 free electrons/cm³. Fig. 3 shows the position and relative density approximately 45 minutes later than Fig. 2. The highest required density during the period 1112–1150 E.S.T. did not exceed 23×10^5 free electrons/cm³.

The mean values show that, during a period of 75 minutes, the center density of the sporadic-*E* cloud decreased over 20×10^5 free electrons/cm³. The drift was observed

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* Received by the Institute, April 30, 1948.

[1] C. Trowbridge, "High altitude air circulation," *Astrophys. J.*, vol. 26, pp. 95–116; September, 1907.

[2] C. P. Olivier, "Long enduring meteor trains," *Proc. Amer. Phil. Soc.*, vol. 85, pp. 93–131; December, 1942.

[3] C. P. Olivier, "Long enduring meteor trains," *Proc. Amer. Phil. Soc.*, vol. 91, pp. 315–342; June, 1947.

[4] V. Malzev, "Luminous night clouds," *Nature*, vol. 118, pp. 14–15; September, 1926.

[5] E. H. Vestine, "Noctilucent clouds," *Jour. Roy. Astr. Soc. Can.*, vol. 28, pp. 249–272; July–August, 1934.

[6] C. Stormer, "Luminous night clouds," *Nature*, vol. 135, pp. 103; November, 1935.

[7] H. R. Mimno, "Physics of the ionosphere," *Rev. Mod. Phys.*, vol. 9, pp. 1–43; January, 1937.

[8] R. Eyfrig, "Echo measurements in long distance transmission," *Hochfrequenz. und Elecktroakustik*, vol. 56, pp. 161–190, December, 1940.

[9] J. E. Best, F. T. Farmer, and J. A. Radcliffe, "Studies of the region-E of the ionosphere," *Proc. Roy. Soc. A.*, vol. 164, pp. 96–116; January, 1938.

[10] E. H. Conklin, "56-megacycle reception via sporadic-E layer reflections," PROC. I.R.E., vol. 27, pp. 36–41, January, 1939.

[11] O. P. Ferrell, "Radio investigation of air movement in the upper atmosphere," *Science and Culture* (Calcutta), vol. 9, pp. 555; June, 1944.

[12] CRPL-F42.

to be about 600 km., corresponding to a velocity of 130 meters. The direction of the drift was due west.

An analysis using the same methods was also made to determine the sporadic-*E* extent and density during the afternoon of July 18, 1947. The plotted contours are shown for four intervals in Figs. 4, 5, 6, and 7. The first period from 1245 to 1344 E.S.T. shows a large sporadic-*E* formation of irregular dimensions. The highest value of contour is 35×10^5 free electrons or equivalents/cm^3. Five instances of radio transmission requiring a density of 39×10^5 free electrons/cm^3 were computed during this interval. In Fig. 5 there is a noticeable change in the position and extent of the sporadic-*E* cloud. Fig. 6, during the period 1433 to 1530 E.S.T., shows a northwestward drift and a diminution of the highest density area. The last interval, Fig. 7, was plotted from observations between 1624 and 1701 E.S.T. A great decrease in the density of the cloud and a further northwest movement are evident. Calculated path length required reflection densities, and observations by the automatic equipment at Washington, D. C.,[13] are in good agreement.

The drift is mostly in the northwest-north direction and was approximately 400 kilometers, corresponding to a velocity of about 40 meters. No attempt has been made to correlate this phenomenon with synoptic weather conditions. It is also to be noted that the sporadic-*E* clouds, when plotted by this method, will be somewhat greater in extent than the actual physical measurements at any given instant.

Extension of this study through a cooperative program combining the analytical facilities of the Geophysical Research Division of the Watson Laboratories and the observations of diligent radio amateurs is contemplated. A description of the methods employed is being prepared and will be published shortly. The author wishes to express his thanks to the numerous radio amateurs for supplying the data employed, and for making this study possible.

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[13] CRPL—F36

Standardization of Nomenclature for Pulse Modulation*

At present there is no general agreement on the names of the various types of pulse modulation. Latterly, different names have been used, leading to confusion.[1,2]

The desirability of standardization has already been expressed.[3,4] Cooke[5] states this very clearly: "Independent investigators have not always arrived at the same nomenclature, and it is felt strongly that an effective and early standardization of terminology, both in this country and abroad, will contribute greatly to clarity of discussion and hence to progress in the art."

As a member of the section 1–60 of the Netherlands Electrotechnical Committee, it appears to me that it is desirable to inform you of what the above-mentioned Committee will propose as recommended terms for pulse modulation in the Netherlands. It is the intention to make an international suggestion of this, that will eventually reach the I.E.C.

With pulse modulation, a pulse train, consisting of a series of fundamentally congruent and equidistant d.c. pulses or groups of d.c. pulses, is modulated. As a rule, the repeating frequency of the pulses will be at least twice the highest frequency of the modulating quantity, simply called "the signal."

A pulse train can be modulated in different ways, of which the more important are: the modulation in pulse rate, in pulse width, in pulse position, and in pulse height. Also conceivable is modulation in pulse slope.

With pulse-rate modulation, the rate of the pulses is a function of the signal. The term "pulse-frequency modulation" is considered undesirable.

With pulse-width modulation, the width of the pulses is a function of the signal. This width can be changed in different ways; for instance, the center of the pulse may remain stationary, in which case one speaks of symmetrical pulse-width modulation. However, there are also symmetrical pulse-width modulations, in which are distinguished, among others, asymmetrical pulse-width modulations with fixed leading edge (the front of the pulse remaining stationary), and with fixed trailing edge (the rear of the pulse remaining stationary).

The names "pulse-length modulation" (causes confusion with height) and "pulse-time modulation" are considered undesirable; the latter term is, at present, mostly used for pulse-position modulation.

With double-pulse modulation, only the beginning and the end of a pulse of a pulse-width modulation are indicated by means of a short pulse; meanwhile, the center collapses.

With pulse-position modulation, the position of the pulses, with respect to a reference point, is a function of the signal.

The terms "pulse-phase modulation," "pulse-displacement modulation," "pulse-time modulation," and "pulse-delay modulation" are considered undesirable.

With pulse-height modulation, the height of the pulses is a function of the signal. The term "pulse-amplitude modulation" is considered undesirable.

With pulse-slope modulation, the slope of one or both sides of the pulses would be a function of the signal.

A form of pulse-modulation, not yet mentioned, is pulse-code modulation. With this method, a characteristic quantity of the signal is transmitted by means of a code of pulse-shaped character. As this code is in principle not restricted by a number or a counting, we deem the term "pulse-count modulation" too limited.

The above-mentioned modulated pulse trains will be able to modulate an alternating-current carrier as an intermediate carrier. At the moment there is no need to create short description terms for the different ways in which these further modulations can take place. However, consideration has been given to the possibility that eventually this need may arise. Herein resides the reason why frequency, phase, and amplitude modulation are deemed undesirable terms for pulse modulation. Should it, for example, be necessary to distinguish briefly the different ways by which a pulse modulation can modulate, as intermediate carrier, an alternating-current carrier, then it is possible to make contractions such as pulse-position-amplitude modulation, pulse-position-phase modulation, etc.

We understand by the phrase, "to pulse a current," the taking out of pulse-shaped samples with constant time duration of a current at equal intervals. This expression is an expedient for the indication of the way in which certain modulation processes take place.

The above-proposed nomenclature has the great advantage that the terms are not confusing, and there is sufficient flexibility to cover future requirements. In this, multiplex transmission has been especially borne in mind.

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* Received by the Institute, March 25, 1948.

[1] F. Rockett, "Modulation types and characteristics," *Electronics*, vol. 20, pp. 124–125; June, 1947.

[2] R. R. Batcher, "Pulse code modulation method for multi-channel telephony," *Tele-tech*, vol. 6, pp. 28–33; July, 1947.

[3] D. Cooke, "Pulse modulation," *Wireless Eng.*, vol. 23, p. 29; January, 1946.

[4] F. F. Roberts and J. C. Simmonds, "Pulse modulation," *Wireless Eng.*, vol. 23, p. 93; March, 1946.

[5] D. Cooke, "Pulse communication, part I," *Jour. I.E.E.*, vol. 94, part IIIA, p. 84; 1947.

Correction*

With reference to the paper by Brunetti and Curtis,[1] my attention has been drawn to the reference no. 8 in the Bibliography on page 161, where you attribute "New Methods of Radio Production" by J. A. Sargrove to the *Journal* of the Institution of Electrical Engineers.

May I respectfully point out that Mr. Sargrove is a member of the British Institution of Radio Engineers, and it was before this body that his paper was first read in February, 1947. The paper was subsequently published in the January/February, 1947, issue of the Institution's *Journal;* i.e., in no. 1, vol. 7 (new series). I would be grateful if you would correct this in your next issue.

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* Received by the Institute, February 6, 1948.

[1] C. Brunetti and R. W. Curtis, "Printed-circuit techniques," PROC. I.R.E., vol. 36, pp. 121–162; January, 1948.