Abstracts of Technical Articles by Bell System Authors

Pulse Code Modulation.[1] H. S. BLACK and J. O. EDSON. A radically new modulation technique for multichannel telephony has been developed which involves the conversion of speech waves into coded pulses. An 8-channel system embodying these principles was produced. The method appears to have exceptional possibilities from the standpoint of freedom from interference, but its full significance in connection with future radio and wire transmission may take some time to reveal.

Modulation in Communication.[2] F. A. COWAN. Any signaling system requires some means for introducing a change in conditions at the sending end which may be recognized at the receiving end. The process by which the conditions are changed has come to be called modulation. There are many varieties of forms of change as well as a large number of conditions which are subject to change in response to the signals to be transmitted.

In early systems for communication at a distance the signal information might have been impressed upon a rising column of smoke, a light, a stone tablet, or a sheet of parchment. For modern communication wide use is made of systems in which the signals change the magnitude or condition of electric energy.

Starting with the electric telegraph a little more than a hundred years ago this medium of communication has grown steadily more important and more complex. To meet a variety of needs many systems of modulation have been developed and papers describing them in detail are available in the technical literature. Various aspects of the modulation processes have been analyzed carefully and presented and some of the earlier conceptions have acquired a classical textbook status. Recent trends have placed emphasis on modulation systems which more readily may be understood when viewed in a somewhat different manner. It is the purpose of this paper to present certain conceptions which may facilitate the understanding of the various systems of modulation and permit an improved perspective.

Frequency Division Techniques for a Coaxial Cable Network.[3] R. E. CRANE, J. T. DIXON and G. H. HUBER. A description is given of developments employing frequency division techniques by which the telephone-message-carrying potentialities of the coaxial cable system are realized. By these methods 480 high quality telephone messages are prepared for

[1] *Trans. A. I. E. E.*,vol. 66, 1947 (pp. 895–899).
[2] *Trans. A. I. E. E.*, vol. 66, 1947 (pp. 792–796).
[3] *Trans. A. I. E. E.*, vol. 66, 1947 (pp. 1451–1459).

transmission over the line and restored to original condition at main terminal points. At intermediate points appropriate groups of channels may be removed, inserted, bridged, or relocated in the frequency spectrum of the line.

Experimental Studies of a Remodulating Repeater.[4] W. M. GOODALL. This paper describes tests made on an experimental broad-band microwave f.m. repeater. A superheterodyne receiving unit is used with a microwave reflex-oscillator transmitting unit to form a repeater. An experimental setup for testing this repeater in a circulating-pulse system is described. Oscillograms showing the performance of the repeater on a multilink basis are discussed.

An Electronic Regenerative Repeater for Teletypewriter Signals.[5] R. B. HEARN. The important factor in teletypewriter signal transmission over circuits is the relative position on a time scale of the code pulses. If this timing is preserved, wide amplitude variations can be experienced without errors resulting. Correctly timed signal pulses at the transmitting end of a circuit are not necessarily properly timed at the receiving end, as the transmission path may shift the timing of some transitions with respect to others. However, if the signals are not too badly changed or distorted, it is possible to retime them at an intermediate point and send them on in their original form.

Many arrangements have been devised for automatically retiming and retransmitting teletypewriter signals. These arrangements are known as regenerative repeaters. A few of these have been designed to make use of electronic timing arrangements and the purpose of this paper is to describe such an electronic regenerative repeater, known as repeater *TG-29*, designed originally for use by the Armed Forces.

Submarine Detection by Sonar.[6] A. C. KELLER. Sonar, the only effective method of detecting completely submerged submarines was a major factor in the defeat of the *U*-boat and the winning of the Battle of the Atlantic. A majority of the 996 enemy submarines sunk during World War II was detected and located by sonar. The word sonar is formed from the phrase SOund Navigation And Ranging and applies broadly to under water sound devices for listening, echo ranging, and locating obstacles.

The QJA sonar system, one of those which got into active service during World War II, is described here. This equipment was designed by Bell Telephone Laboratories and manufactured by the Western Electric Company.

[4] *Proc. I. R. E.*, May 1948 (pp. 580–583).
[5] *Trans. A. I. E. E.*, vol. 66, 1947 (pp. 904–911).
[6] *Trans. A. I. E. E.*, vol. 66, 1947 (pp. 1217–1230).

Measurement of High Q Cavities at 10,000 Megacycles.[7] R. W. LANGE. Known methods of measuring Q in high Q resonant cavities, together with their accuracies and sources of error, are discussed. For relatively low values of Q and of frequency, it is shown that band width methods are more accurate than decrement methods. For values of Q above 30,000 at frequencies above 3,000 megacycles the reverse is true. The significant feature of the present method, the wide range heterodyne decrement method, is that the accuracy is improved by observing the decay over a relatively long interval of time. An absolute accuracy of plus or minus three per cent and a relative accuracy of plus or minus two per cent are achieved. Design features and performance are discussed and constructional details are presented.

Absorbing Media for Underwater Sound Measuring Tanks and Baffles.[8] W. P. MASON and F. H. HIBBARD. By using absorbing walls surrounding a small body of water, measuring tanks have been produced which will determine the directional properties of underwater sound instruments down to a level of 25 db below the direct beam. These absorbing media are constructed by inserting fine mesh screen or packed copper wadding in a viscous liquid such as castor oil. These obstructions result in an enhanced viscous action which is nearly independent of the frequency above 10 kilocycles. A six-inch wall can reduce the reflections by 20 db. Tanks using such absorbing media were used for testing transducers at the manufacturing plant and were used for determining the approximate characteristics of small sized instruments. Absorbing media were also used in the sound transparent dome housing the transducer and in the back of the QJB transducers.

Calculation of the Directivity Index for Various Types of Radiators.[9] C. T. MOLLOY. This paper gives the derivations of the "directivity index" formulas for several types of sound radiators. The "directivity index" is defined as "the ratio of the total acoustic power output of the radiator to the acoustic power output of a point source producing the same pressure at the same point on the axis." The utility of the directivity index concept is that it permits power calculations to be made for all radiators in the same manner as for point sources. Directivity index formulas, together with graphs covering practical cases, are given for the following types of radiators:

1. General plane piston in infinite baffle,
2. Circular plane piston in infinite baffle,
3. Rectangular plane piston in infinite baffle,
4. Sectoral horn,

[7] *Trans. A. I. E. E.*, vol. 66, 1947 (pp. 161–166).
[8] *Jour. Acous. Soc. America*, July 1948 (pp.476–483).
[9] *Jour. Acous. Soc. America*, July 1948 (pp. 387–405).

5. Multicellular horn,
6. Piston set in sphere.

A Magnetic Field Strength Meter Employing the Hall Effect in Germanium.[10] G. L. PEARSON. The instrument to be described measures magnetic field strengths as determined from the Hall effect in germanium. The essential parts of this instrument include a small germanium probe, and a panel type microammeter calibrated directly in gauss. Its accuracy is ±2 percent at fields between 100 and 8000 gauss. At higher fields the readings are too low, the error amounting to 9 percent at 20,000 gauss. The chief advantages of this instrument are: (a) small size and portability, (b) continuous reading rather than ballistic as in ordinary field strength meters, and (c) a small nonmagnetic probe with which one can search in very narrow gaps.

The Representation of Vowels and their Movements.[11] RALPH K. POTTER and GORDON E. PETERSON. It is shown that movement of the major resonances in the voiced sounds of speech may be represented by traces in a three-dimensional graph. Apparently a great deal can be learned about speech through investigation of such traces, and they suggest a new method for vowel designation that is particularly adaptable to quantitative analysis.

General Mobile Telephone System.[12] H. I. ROMNES and R. R. O'CONNOR. The tremendous need for communication with ships, airplanes, trucks, tanks, and other mobile units used in such large quantities during the war accelerated the development of practical mobile radiotelephone equipment for use in the 30 to 200 megacycle range and emphasized the practicability and usefulness of mobile telephone service. By the end of the war the art had advanced sufficiently in the applications of these higher frequencies so that it seemed practicable to provide telephone service to mobile units on a general basis rather than limit it to safety and emergency services as had been the case before the war. The Federal Communications Commission therefore made available a few frequencies for experiments in this field. In the two years which have elapsed, the Bell System has made this service available on an experimental basis in more than 60 cities and about 100 more systems are under construction. This paper describes the arrangements used and outlines the experience obtained to date with this service. Improvements are being made constantly so that this must be regarded as an interim report on a rapidly changing and expanding service.

Interference between Very-High-Frequency Radio Communication Circuits.[13] W. RAE YOUNG, JR. Interference between different radio circuits is an old problem, one which in the past generally has been solved by trial and error

[10] *Rev. Sci. Instruments*, April 1948 (pp. 263–265)
[11] *Jour. Acous. Soc. America*, July 1948 (pp. 528–535).
[12] *Trans. A. I. E. E.*, vol. 66, 1947 (1658–1666).
[13] *Proc. I. R. E., Waves and Electrons Section*, July 1948 (pp. 923–930).

and by hand tailoring (special filters, etc.). With the general increase in the usage of radio communication, however, the amount of potential interference is greatly increased. This paper will be concerned principally with the v.h.f. problem.

There is generally a large difference between transmitting and receiving power levels. As a result, spurious radiations, spurious responses, and lack of sufficient receiver selectivity may in many instances cause interference. Situations are described in which such interferences are likely.

In mobile systems interference can occur if the interfering station is close enough to "capture" it from the desired signal. This, in turn, depends upon the selectivity and spurious response of the receiver and the amount of spurious radiation from the transmitter. The problem can be approached in a statistical manner.

The types of spurious radio behavior which are common causes of interference are discussed. Sample measurements are given to illustrate the relative magnitude of the various modes of behavior. Formulas are given which permit computation of the frequency of the disturbances. A method is described for making charts suitable for a given type of equipment from which the spurious frequencies can be read directly as a function of the operating frequency.