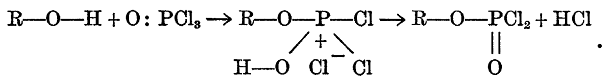
The formation of such high-molecular-weight cyclic compounds explains both the high molecular weights observed for such products and the type of infrared spectra exhibited by them. Even larger molecules can be visualized by extending the above representation further. In addition, a similar formulation serves to explain the formation of apparently identical substances by the interaction of phosphorus pentoxide with triethyl phosphate (Adler and Woodstock. *Chem. Industr.*, 1942, 516).

The concept of addition reactions to the PO linkage has been mentioned by Gerrard (*J. chem. Soc.*, 1945, 106) as a possible mode of reaction of alcohols with phosphorus oxychloride, through an intermediate adduct of a type ROH . . . $OPCl_3$. It is possible, however, to modify this concept and to formulate such a reaction by



means of a ''phosphonium type'' mechanism similar to that used above.

Such a formulation, in so far as known, is not contrary to known facts about the interaction of phosphorus oxychloride with primary alcohols and may serve as a bridge between the chemistry of the pentavalent phosphorus compounds and the chemistry of trivalent phosphorus compounds, where the formation of ''phosphonium type'' adducts has been observed in numerous cases. The actual formation of an adduct between an alcohol and phosphorus oxychloride has been shown by the determination of molecular weights of equimolecular mixtures of *n*-octanol and phosphorus oxychloride in benzene at 3–4° C. Within 5 min of addition the average molecular weight was found to be 186.3; 1 hr later the value rose to 195.5, indicating a slow and steady accumulation of an adduct. After 1 hr the mixture began to evolve hydrogen chloride (which may be formulated as given above), and the value of the average molecular weight obviously began to drop. This appears to be the first instance of detection of an adduct of an alcohol with phosphorus oxychloride. Attempts to use alcohols of lower molecular weights gave mixtures in which the evolution of hydrogen chloride began at much lower temperatures, such as to preclude reliable measurements with conventional solvents.

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Why Vegetation on Watersheds?

''Save our forests and humus to conserve our water supply.'' ''Forest and brush fires will deplete our water supply.'' These and similar slogans have given the public an erroneous idea of the relation between a storage reservoir and vegetation.

The following remarks apply only to the strictly utilitarian but vital problem of watersheds which drain into *storage* reservoirs of sufficient size to hold the entire annual precipitation. There exists among the laity a misunderstanding engendered by numerous articles which have not stressed the wide difference between water *storage* and undammed rivers.

A storage reservoir is just what its name implies—a dam across a drainage artery to conserve the run-off from its watershed, for subsequent distribution to consumers. Is vegetation on such a watershed of value in the sense in which it is ordinarily understood, or is its chief value altogether different?

If you lived in southern California, or in a location with similarly distributed rainfall, and had a large cistern for catching rainwater from your roof, you could estimate your approximate annual storage, if you knew the area of your roof and the average amount of rainfall. Your roof may be likened to a watershed and your cistern to a storage reservoir. Your roof is devoid of vegetation, but you understand that vegetation is vital to your community's watershed and storage reservoir. Therefore, if you are consistent, you should hasten to cover your roof with boxes filled with leaf mold or humus supporting a luxuriant growth of plants to ''conserve your water supply.'' The plants and humus on your roof will do exactly what they would do on your community watershed, namely, catch and hold part of the water that would have gone into your cistern. The luxuriant plants gradually absorb much of it and breathe it out into the atmosphere. The remainder evaporates from the surface of the humus, except for a little which has been delayed and gradually seeps out of the boxes, but most of this seepage evaporates before reaching your cistern.

Looked at in this light, it is evident that vegetation on a watershed draining into a storage reservoir causes a waste of water. The evaporation from the surface of the impounded lake is but a fraction of the loss sustained by the evaporation from vegetation and from the ''delayed'' water which gradually seeps toward the reservoir, but is largely lost by capillarity and the ensuing evaporation. Therefore, vegetation on a watershed is a detriment in so far as saving all the water that falls is concerned.

As one sails among the West Indies, or other places that suffer from protracted droughts, one notes large white areas on the hillsides above the towns. These are water-catching areas that drain into reservoirs. The authorities would no more think of covering them with vegetation than you would your roof from which you expected to fill your cistern. How do these catchment areas differ from the watershed of your community? The *white* areas are solid cement pavement—very rough, unadorned, and purely utilitarian, but very effective.

Now we come to the real and vital need for vegetation on our watersheds. It is purely mechanical. If there is erosion, the reservoir will *fill* with detritus and you will be without storage *space*. If you could have your watershed covered by ''gunnite'' or paved, you could recover all but a negligible fraction of the rainfall. Therefore, the only use of vegetation on your watershed is to *hold* loose soil in place and prevent it from filling your reservoir. The holding back of rainfall by vegetation and humus is wasteful of water.

The watershed of an undammed river is a different proposition, since it is desirable to delay the water as much as possible so that it will not rush to the ocean. In this case, it is the *delayed* water that interests us. The far greater portion of it that is evaporated by the vegetation is the price we gladly pay to insure a small but steady flow in the valley.

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Book Reviews

Microwave transmission circuits. (Massachusetts Institute of Technology Radiation Laboratory Series.) George L. Ragan. (Ed.) New York-Toronto-London: McGraw-Hill, 1948. Pp. xvii + 725. (Illustrated.) $8.50.

This is one of a set of 28 volumes forming the Radiation Laboratory Series, in which information previously available only in classified reports, or in many cases unpublished information, is recorded. Most of the material concerns techniques evolved during the war in the development of microwave radar.

The term *microwave* designates radio waves roughly in the range of wave lengths between 1 and 30 cm. As these wave lengths are of the same order as the dimensions of the various circuit components, new problems arise which are not present at lower frequencies. The wave aspects of electromagnetism become of increased importance, whereas the electric currents are of less importance and the concept of *voltage* is generally ambiguous.

In common with low-frequency circuits, the microwave systems can generally be divided into three parts, generators, receivers, and interconnecting elements. The book under discussion concerns itself solely with the interconnecting elements. In a microwave circuit these elements consist of transmission lines of various types and junctions between these transmission lines. Engineering problems connected with these circuit elements are extensively treated. Included are coaxial and wave guide transmission lines, both rigid and flexible. Power dividers, tuners, couplings, and switches may be mentioned as examples of transmission line junctions. There is a section on microwave filters and an introductory chapter on the theory of the transmission line.

Although 7 authors contributed to the book, it is well organized and has little overlap. It is reasonably complete. A description of the magic tee and its various uses, such as power divider, tuner, and line stretcher, seems, however, to be missing. The book is valuable largely because of the engineering data which it contains.

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Higher algebra: a sequel to "Higher algebra for schools." W. L. Ferrar. Oxford, Engl.: Clarendon Press; New York: Oxford Univ. Press, 1948. Pp. vii + 320. $5.00.

Although this book is a sequel to *Higher algebra for schools,* it is not written so that the earlier book is the only source of the needed preliminary knowledge. The material is planned for study in "top mathematical forms in schools and first year classes in universities." There are discussions of series, complex numbers, difference equations, theory of equations, partial fractions, inequalities, and continued fractions. There is no general discussion of convergence and divergence, the summing of finite and infinite series being stressed. A lucid introduction to complex numbers uses directed number, or vector, as the basic definition. Thus, Demoivre's theorem is readily obtained and is used in the next chapter to yield many trigonometric identities; bilinear transformations are another application of complex numbers. The relations between the coefficients of an equation and the symmetric functions of its roots, and the exact solutions of a cubic and a quartic, are the principal topics in the theory of equations. Several general inequalities are given, including Hölder's and Minkowski's.

The manipulation of algebraic expressions is a central feature, and in this respect the work has the same spirit as that classic treatise with the same title by Hall and Knight. The level of rigor can best be indicated by pointing out that convergence and continuity are not defined in a precise way, but intuitively: "A function $f(x)$ that changes its value gradually as x changes gradually is said to be continuous." Thus, many results cannot be proved rigorously, although, surprisingly enough, the word "proof" is used without qualification, e.g. in the "proof" (pp. 135–136) that if a polynomial $f(x)$ is positive for $x = a$ and negative for $x = b$, then $f(x) = 0$ has a root between a and b. The author makes it clear that he feels that precision in these matters may well wait: ". . . the intending mathematician must be prepared for a considerable refinement . . . ."; and yet he expects his readers to perform intricate and ingenious manipulation with some very difficult problems. But if students are not benumbed by these problems, they are surely ready for some critical mathematics. In addition to this criticism, the absence of determinants will restrict the usefulness of the book as a text on this continent. Most Canadian and American college students are, of course, not prepared for this material in their first year.

Only a few errors were noted. For example, multiplication by zero is never defined in the development of complex numbers; the fact that an algebraic equation of degree n in the complex field is solvable and has n roots is not even stated, let alone proved, but is used; and Theorem 38 is needed in proof of Theorem 37.

As a book in the celebrated English tradition of elementary mathematical texts, placing great emphasis upon, and replete with, manipulative problems, the volume is a success.

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