Staudinger and coworkers have found, in a series of investigations [1], that for dilute solutions of organic substances having linear molecules there is a direct relationship between viscosity and chain length. For basal molar solutions of alkanes this relationship may be expressed by the equation:

$$\eta_{sp}(1.4%) = n; y,$$

where $\eta_{sp}$ is the specific viscosity, $n$ is the number of links in the chain, and $y$ is the specific viscosity per member of the chain for the given solvent ($1.3 \times 10^{-5}$ for benzene and $1.5 \times 10^{-5}$ for carbon tetrachloride) [2]. By the aid of this relation Staudinger, in a number of investigations, drew inferences concerning the configurations of organic molecules in dilute solutions. Thus, Staudinger found from viscosity measurements that the higher fatty acids are present in solution in the form of extended double molecules [3]:

$$\text{CH}_2\text{(CH}_2\text{nCH}_3$$

also [4], secondary and tertiary amines are present in solution not in the forms I and II, but in the extended forms III and IV:

$$\text{CH}_2\text{(CH}_2\text{nCH}_3$$

Similar extended molecules were found by Staudinger also for acid anhydrides [5], esters of dibasic acids [6], and esters of glycerol (form VI, not V):

$$\text{CH}_2\text{O- CO- (CH}_2\text{nCH}_3$$

We have found in our previous investigations [8] that the parachor can give us an idea of the way in which the chains are disposed in organic compounds of certain type. Thus, according to parachor data on phosphorous esters, only two of the three chains are disposed parallel to one another (VII) [9, 12]. A similar picture is presented by boric esters (VIII) [10] and by tertiary amines (IX) [11]: (see top of next page). However, the parachor indicates that in phosphoric esters (X) and phosphorothionic esters [12] the three chains are disposed in parallel array. It was of interest to compare the conclusions derived from these parachor data with those derived from viscosity measurements. For tertiary amines [11] parachor and viscosimetric [4] measurements gave similar results.

In the present communication we give results of viscosimetric measurements that we have made on phosphorous, phosphoric, phosphorothionic, and boric esters, chosen, in each case, so as to have ether chains of sufficient length. The results obtained for phosphorous esters are given in Table 1.
Comparison of the values of $\eta_{sp}(1.4\%)$ and $Z_\eta$ found experimentally with those calculated for a parallel disposition of only two chains ($-P=\pi$) and for a parallel disposition of all three chains ($P=\pi$) shows quite clearly that, according to viscosity data, in dilute solution trialkyl phosphites have only two parallel chains, which is in accord with parachor data.

The results of viscosity determinations on boric esters are summarized in Table 2.

The viscosity data for boric esters definitely indicate molecules of extended form having only two ester chains disposed in parallel fashion, which is in accord with parachor data. The results of viscosity measurements on phosphoric and phosphorothionic esters are given in Table 3.

As the results in Table 3 show, the values of $\eta_{sp}(1.4\%)$ and $Z_\eta$ indicate an extended form of molecule for phosphoric and phosphorothionic esters in dilute solution and are thus at variance with parachor data for these compounds, according to which all the three esters interact with one another. The nonaccord of these conclusions concerning the structures of phosphoric and phosphorothionic esters makes it desirable to carry out further investigation into the questions: In the analysis of parachor data, what do the corrections for parallelism indicate? What does viscosity measurement yield for molecules of branched structure?

The results of numerous researches by Staudinger and coworkers indicate that, according to viscosity data, molecules have an extended form in solutions. The results of Staudinger [13] according to which the pyridine salt of dioctylacetic acid has the structure XI, which has a nonextended form and not the extended form of a dioctylacetic ester (XII), are not very convincing, for the chains have in each case the same length (17 members*):

* If all the atoms of the pyridine ring are considered to be in the chain.