compute the distances applies throughout these two planes, Nos. 1 and 2 of Fig. 17, and gives a result close to measured values.

Planes 3 and 4 may be regarded as turned upside down from those of 1 and 2, that is to say, the center of the tetrahedron in plane 3 is below instead of above as before. By changing the definition of the lines in Fig. 19, and making the central arrow point upward instead of downward, and making the arrows 2, 3 and 4 point *downward* toward the center of a tetrahedron instead of upward, Fig. 18 will also serve for these planes, and that includes all planes of oxygen atoms in the ice crystal.

It will be recalled that there are two chief sources, as pointed out in Chapter IX, by which the theory yields information about atoms in the steady states. The first concerns the action of the force upon the positive nucleus of the atom that causes the internal deformation. This is the only one that has been made use of thus far in this account. The second source is the total force upon the whole atom that must be equated to zero for an equilibrium condition. This yields information concerning the *amount* of displacement within the atom, for example, the distances the electrons move away from the equator of the atom during the formation of a compound. For the present we will not go into the matter of the equilibrium condition.

CHAPTER XIV

BENZENE (C_6H_6).

To stress the importance of this investigation I can do no better than quote from Thomsen's "Thermochemistry," as follows:

"The constitution of benzene has been a much disputed problem; for, on the one hand, it was assumed that the six carbon atoms were united by three single and by three double bonds, on the other, that the molecule contained nine single bonds. The investigations described have confirmed the accuracy of the last supposition." And subsequently he writes "Consequently each of the nine bonds between the carbon atoms of benzene corresponds to a thermal effect of 14.09 large calories."

This energy is a little less than the figure used in Chapter VIII, which applies to amorphous carbon and the chain hydrocarbons.

The common representation of the carbon ring in benzene is as in Fig. 20, where the bonds, all equal each to each, alternate from one to two around the ring. This has taxed the ingenuity and resources, and strained the credulity of scientists for many years — to understand why there should be two bonds between some and only one between others, since the atoms are supposed to be all alike.

The Crehore atom and theory gives a definite rational answer to this old question, and confirms the experimental researches of Thomsen that there are nine equal single bonds and no double ones. They are represented in Fig. 21. Each carbon atom has one bond to each of its adjacent two atoms and a third bond of equal value to the diametrically opposite carbon atom. This makes six bonds around the circumference and three as diameters, a total of nine single bonds.

There are no bonds between the alternate atoms in the ring. To most chemists it must seem passing strange and almost incredible that the effect — whatever it is — can skip over nearer atoms and attach itself to a more distant one. Indeed this whole subject has remained obscured for ages because the effect of the directions of the axes of the atoms has been entirely ignored. Until they are introduced and admitted into the account the misunderstanding about all these matters will necessarily continue.

Those who have followed the preceding chapters, and the book, a "Mathematical Treatise on the Crehore Atom," will recall that in the example of graphite (Chapter XII), there were nine nearest atoms that had no bond with the selected atom, and that this was due to the

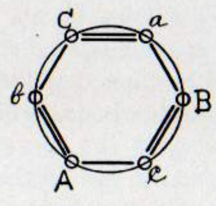

FIG. 20.

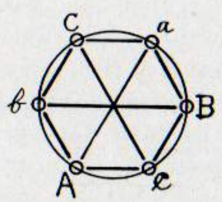

FIG. 21. Nine equal bonds in the benzene ring in the Crehore theory.

system of directions of the axes of the atoms. When the angle between axes is 90°, the force upon the positive nucleus reduces to zero because of the cosine of the angle in the formula. For carbon on carbon by Table I (Chapter VII), the average force upon the positive charge or nucleus of the first atom due to a second carbon atom is

$$F = \frac{e^2}{k}\left\{-18(D+H)_C \cos\alpha \, r^{-3}\right\},$$

and this vanishes when the angle is 90°.

Fig. 22 is offered to assist in showing how the angles between the axes of the atoms in the benzene ring can produce the nine equal single bonds shown in Fig. 21. It is often difficult to show by a plane figure how the angles between lines in a spatial perspective view really look;

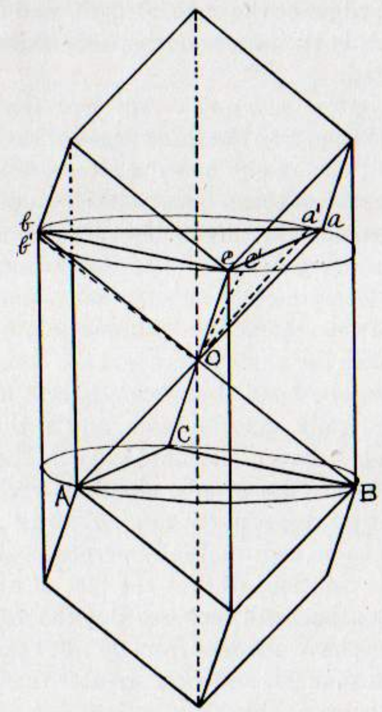

FIG. 22.

so, to assist the eye, two cubes are shown with a common vertical diagonal touching each other at the common corner, O. The upper edges of the lower cube and the lower edges of the upper cube coincide in direction, the line AOa being one straight line. Similarly BOb and COc are straight lines.

Thus the figure shows three mutually perpendicular lines, Aa, Bb