there was obtained a total of 2 g. (24% of the theoretical amount) of the desired amino acid. The product melted at 272° (uncorr.) and the picrolonate darkened at 176–179° and melted at 179–180°. Barger and Coyne report the two melting points as 281° and 178°, respectively.

Anal. Subs., 0.1584, 0.1080: $BaSO_4$, 0.2521, 0.1692. Calcd. for $C_5H_{11}O_2NS$ S, 21.5. Found: S, 21.84, 21.51.

Summary

A new synthesis of methionine, γ-methylthiol-α-amino-*n*-butyric acid, has been described.

URBANA, ILLINOIS

COMMUNICATIONS TO THE EDITOR

THE SPECTROSCOPIC DETERMINATION OF THE DECOMPOSITION PRODUCTS OF ORGANIC COMPOUNDS. BENZENE IN THE ELECTRODELESS DISCHARGE

Sir:

An interesting and beautiful phenomenon is observed if benzene vapor at about 0.1-mm. pressure is subjected to the electrodeless discharge. At first a greenish glow appears near the walls of the flask adjacent to the wires. Almost immediately this spreads through the entire flask, turns red, and is extinguished by the resultant decomposition and recombination to form a solid hydrocarbon. This stops the discharge by lowering the pressure. After 40 discharges of this type the walls of the flask are found to be covered by a thin, transparent, amber-colored deposit.

However, if benzene vapor is admitted at just the rate to keep the pressure at a value suitable for the discharge, the glow persists and the accompanying decomposition and synthesis proceed continuously for an hour or more. Thus several thousand liters of the vapor are completely decomposed and quantitatively converted into a reddish-brown flaky powder. This has the same composition as benzene, according to the analysis of Dr. I. E. Muskat, but a much higher molecular weight. The formula is thus $(CH)_n$.

The spectrum, (Fig. 1) indicates that the benzene molecules rapidly decompose into molecules of C_2 and CH, and atoms of C^+ and H. Thus the 5 groups of Swan bands, and a considerable number of the other C_2 bands, as discovered by Deslandres and D'Azambuja, were found, as well as the λ4300 and λ3900 bands of CH. In addition the first four lines of the Balmer series of hydrogen, and the line spectrum of C^+ appeared.

The C_2, CH, C^+ and H seem to combine completely to form the reddish-brown hydrocarbon, as evidenced by the fact that several thousand liters of benzene vapor decompose without giving enough gaseous residue to raise the pressure sufficiently to extinguish the discharge.

The spectra were photographed by Hilger quartz spectrographs, and a

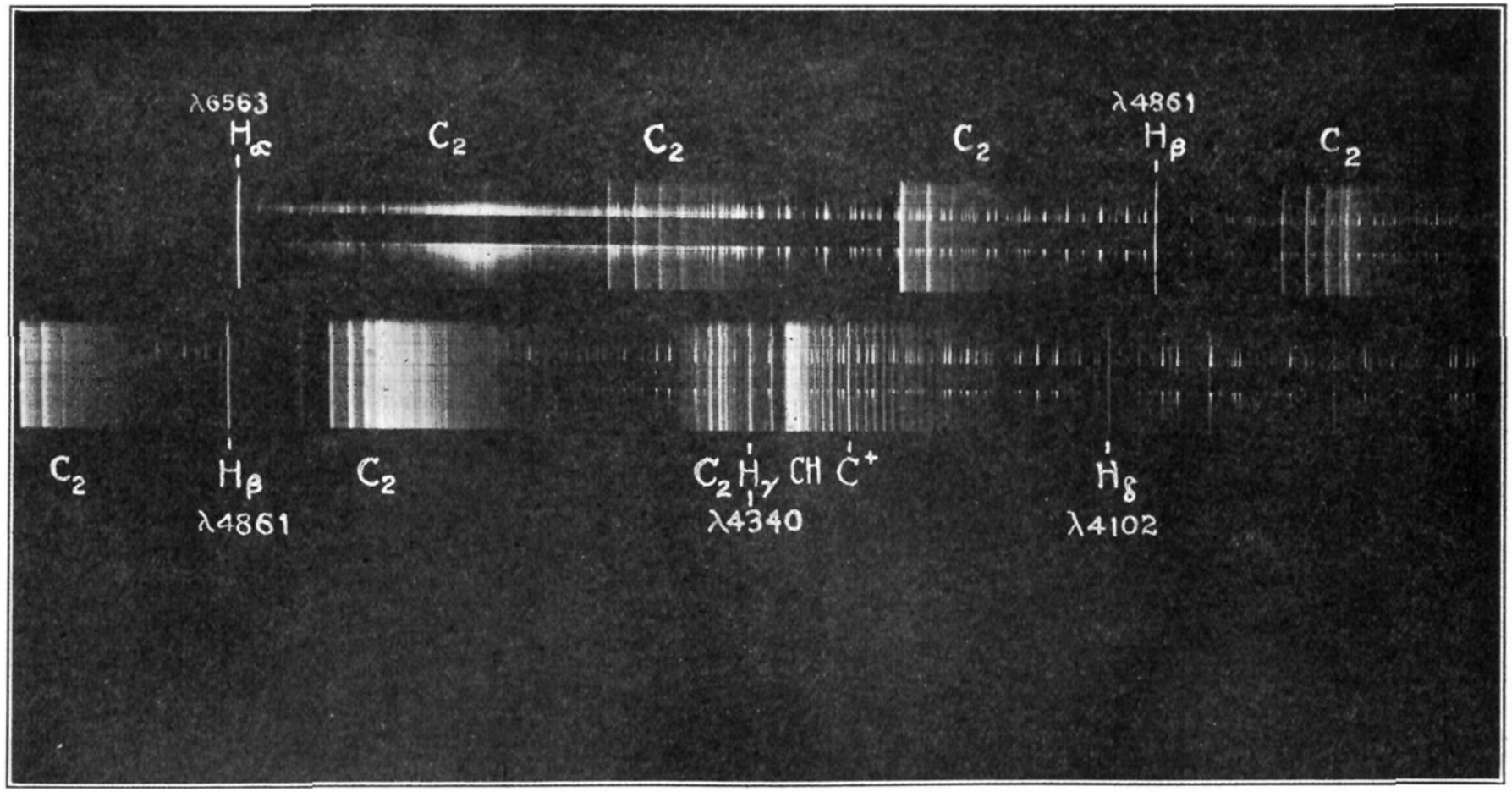

Fig. 1.—Spectrum of molecules of C_2 and CH, with the first four lines of the Balmer spectrum of hydrogen, together with lines of the C^+ spectrum, as obtained from the decomposition products of benzene in the electrodeless discharge, with a frequency of 1000 kilocycles per second.

Steinheil glass spectrograph of high dispersion. The apparatus (Fig. 2) consisted of a liter flask with a quartz window, connected with a gage and vacuum pump, and surrounded by 6 coils of wire from a 25,000-volt transformer and a condenser of 0.02 microfarads capacity. This stores about 1 calorie of energy at 25,000 volts. The benzene is dried with great care before it is put into the apparatus, and its vapor passes through a tube (D) of phosphorus pentoxide just before it enters the flask.

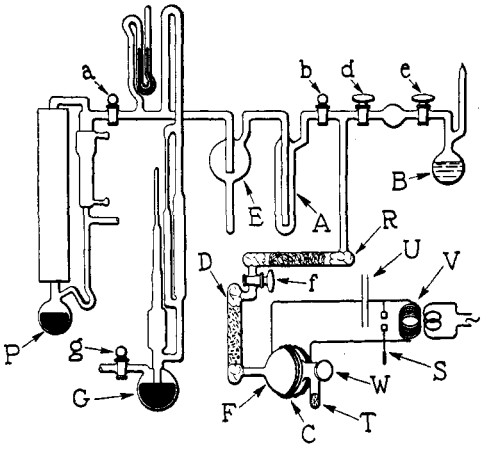

Fig. 2.—Apparatus for the decomposition of organic vapors.

The frequency of the discharge was 1000 kilocycles per second. The pressure at which the discharge acts rises with increasing distance between the terminals of the spark gap. Thus with a 1.5-mm. spark gap the maximum pressure is 0.05 mm., while with a gap of 6 mm. the maximum pressure is 0.25 mm.

In so far as the spectra found are excited by electronic collisions, the velocities of the electrons range between 1.9 and 3.6 volts or between 0.85×10^8 and 1.14×10^8 cm. per second. The limits probably extend farther in each direction. The intermediate products in the decomposition of other organic compounds, such as methane, acetylene, phenol, etc., will be determined, since the spectroscopic method is one of great convenience and usefulness.

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THE HEAT OF FORMATION OF MOLECULAR OXYGEN

Sir:

The reported values for the heat of formation of molecular oxygen range from 162,000 to 110,000 calories. These values have all been determined by indirect methods. A direct determination of the heat of formation of molecular oxygen has now been obtained using an apparatus essentially the same as that of Bichowsky and the author[1] for hydrogen. This apparatus employs the method of Weide and Bichowsky[2] for determining the

[1] Bichowsky and Copeland, This Journal, **50**, 1315 (1928).

[2] Weide and Bichowsky, *ibid.*, **48**, 2529 (1926).