internal rotation of simple molecules closely related to the polypeptide chain.[8]

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(8) See also S. Mizushima, T. Shimanouchi, *et al.*, THIS JOURNAL, **73**, 1330 (1950); **74**, 270 (1952); *Nature*, **169**, 1058 (1952).

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HYDROGEN TRANSFER REACTIONS ACCOMPANYING THE COBALT CATALYZED SYNTHESIS FROM ACETYLENE, CARBON MONOXIDE AND METHANOL

Sir:

Acetylene reacts with carbon monoxide and methanol in presence of a cobalt catalyst and it is known that in this reaction a mixture of esters can be obtained.[1] Using a dissolved cobalt catalyst, *e.g.*, $(Co(CO)_4)_2$ the reaction proceeds much more rapidly and no metallic cobalt is found in the reaction products.

Acting at very low temperature (90–110°) and at high CO pressure (200–300 atm.) in presence of 2% dissolved $[Co(CO)_4]_2$ as catalyst the following products are identified, the yield being dependent primarily on the concentration of the acetylene:

	Product	Yield, g./100 g. C_2H_2	Notes
1	Methyl acrylate	14–24	Identification by reaction with CH_2N_2[2]
2	Cyclopentanone	Traces	2,4-Dinitrophenylhydrazone m.p. 146°[3] mix. m.p. with an authentic sample, 146°
3	Δ^2-Cyclopentenone-1	2–10	B.p. (760 mm.) 154–155°; n^{20}_D 1.4787; U.V. spectrum[4] λ = 309 mμ, log ϵ = 1.50; 2,4-dinitrophenylhydrazone m.p. 165–166°,[5] *anal.* N: found 21.8; calcd. for $C_{11}H_{10}O_4N_4$: 21.37
4	Dimethyl fumurate	1–14	M.p. 101.2–101.4°; mixture m.p. with an authentic sample, 101.2°
5	Dimethyl succinate	70–250	M.p. 19°, n^{20}_D 1.4484
6	Trimethyl ethanetricarboxylate	35–50	M.p. 34.5°; *anal.* found C, 47.19; H, 5.89; calcd. for $C_8H_{12}O_6$, C, 47.058; H, 5.882
7	Dimethyl γ-ketopimelate	40–60	M.p. 56°; *anal.* found: C, 53.3; H, 6.85; calcd. for $C_9H_{14}O_5$: C, 53.46; H, 6.93

The formulas of the products 1 and 5 are in agreement with the addition of one or two molecules of carbon monoxide and methanol to one molecule of acetylene.

On the contrary the composition of the other products does not correspond to the sum of molecules of acetylene, carbon monoxide and hydrogen but shows a higher or lower hydrogen content. Therefore any solid catalyst being absent the products 2, 4, 6, 7, must arise from some homogeneous hydrogen transfer reaction like the one observed[6] in the synthesis of esters or amides from olefins, carbon monoxide and alcohols or amines.

The hydrogen necessary for the synthesis of the cycloketones and γ-ketopimelic acid dimethyl ester, does not seem to be supplied by the dehydrogenation of methanol because no appreciable amounts of formaldehyde, or its derivatives, has been detected.

Also the formation of hydrogen by reaction between carbon monoxide and water cannot proceed to a large extent because anhydrous reagents were used, and no dehydration products of the reactants (for example, dimethyl ether) has been found in the liquid or gaseous reaction products.

Presently it seems more probable that the succinic acid dimethyl ester acts as hydrogen donor the first dehydrogenation product being the fumaric acid dimethyl ester.

Moreover, only a small amount of the last compound is detected in the reaction products, the most part being transformed in ethanetricarboxylic acid trimethyl ester, by reaction with carbon monoxide and methanol.

The very low temperature at which the synthesis of esters and ketoesters seems to take place,[7] from the intermediate olefinic compounds carbon monoxide and methyl alcohol, is not surprising if we consider the hydrogen transfer reactions as typical chain reactions.

We can conclude that hydrogen transfer reactions take place very easily with cobalt catalysts in presence of high carbon monoxide pressure. The cobalt catalysts probably act as hydrogen carriers according with the equilibrium

$$[Co(CO)_4]_2 + H_2 \rightleftarrows 2[Co(CO)_4]H$$

which can occur at high carbon monoxide pressure in presence of movable hydrogen atoms.

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(1) G. Natta and P. Pino, Swiss Patent Ges. N. 46197 (June 24, 1949): *La Chimica e l'Industria*, **31**, 249 (1949).

(2) *Ber.*, **33**, 3595 (1901).

(3) THIS JOURNAL, **57**, 758 (1935).

(4) *Ibid.*, **74**, 514 (1952).

(5) *Ann.*, **539**, 207 (1939).

(6) G. Natta, P. Pino and R. Ercoli, THIS JOURNAL, **74**, 4496 (1952).

(7) G. Natta, P. Pino and E. Mantica, *Gazz. Chim. Ital.*, **80**, 650 (1950); *La Chimica e l'Industria*, **32**, 201 (1950).

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THE MECHANISM OF VIRUS ATTACHMENT TO HOST CELLS. III[1]

Sir:

The chemical basis of virus attachment to its host cell has not previously been elucidated. Earlier studies from this laboratory have shown that the first phase of invasion of a host cell by a bacterial virus consists in establishment of strong electrostatic bonds between sites on the two surfaces.[2,3] Some of the evidence on which these conclusions were based is as follows: The initial attachment is exceedingly rapid, being diffusion-limited; its rate is constant between 0 and 37°; it can be readily reversed by appropriate changes of the ionic constituents of the medium; and its

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(2) T. T. Puck, A. Garen and J. Cline, *J. Exp. Med.*, **93**, 65 (1951).

(3) A. Garen and T. T. Puck, *ibid.*, **94**, 177 (1951).